HOUSATONIC RIVER FLOOD CONTROL

DERBY, CONN.

LOCAL PROTECTION

HOUSATONIC & NAUGATUCK RIVERS, CONNECTICUT

DESIGN MEMORANDUM NO.1

HYDROLOGY AND INTERIOR DRAINAGE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JANUARY 1968

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO

NEDED-H

10 January 1968

SUBJECT: Derby Local Protection Project, Housatonic and Naugatuck Rivers, Connecticut, Design Memorandum No. 1 - Hydrology and Interior Drainage

TO: Chief of Engineers
ATTN: ENGCW-E

There is submitted herewith for review and approval Design Memorandum No. 1, Hydrology and Interior Drainage for Derby Local Protection Project, Housatonic River Basin, in accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

John Wm. Leslie

JOHN WM. LESLIE
Chief, Engineering Division

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as (5 cys)

DESIGN MEMORANDA INDEX

No.	Title	Submission Date	Approved
1	Hydrology & Interior Drainage		
2	General Design		
3	(Deleted)		
4	Concrete Materials		
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DERBY LOCAL PROTECTION PROJECT
HOUSATONIC AND NAUGATUCK RIVERS
CONNECTICUT

DESIGN MEMORANDUM NO. 1

HYDROLOGY AND INTERIOR DRAINAGE

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DERBY LOCAL PROTECTION PROJECT
HOUSATONIC AND NAUGATUCK RIVERS
CONNECTICUT

DESIGN MEMORANDUM NO. 1

HYDROLOGY AND INTERIOR DRAINAGE

1. INTRODUCTION

a. Purpose. The purpose of this memorandum is to describe pertinent hydrologic criteria and the interior drainage plan for the Derby Local Protection Project in Derby, Connecticut on the Housatonic and Naugatuck Rivers. Part I, Hydrology, includes sections on climatology, streamflow, flood history, standard project floods and project design floods. Part II, Interior Drainage, describes the interior drainage basin, damage potential, design criteria and the proposed drainage systems.

b. Background. The Derby Local Protection Project, although engineeringly integral with the Ansonia-Derby Local Protection Project, was authorized in October 1965, Public Law 89-298. The Ansonia-Derby Project was authorized in October 1962 and design is now complete.

c. Coordination with local authorities. The general design has been developed with the knowledge and concurrence of the officials of the city of Derby who will be furnished copies of all design memoranda for use and comment.

PART I - HYDROLOGY

2. DESCRIPTION OF PROJECT AND WATERSHED

a. Project description. Flood protection will be provided along two sides of the city of Derby, on the north bank of the Housatonic River and the west bank of the Naugatuck River as shown on plate 1-2. Protection along the Housatonic River will start in the vicinity of Bridge Street bridge with a 370-foot long floodwall joining an earth dike and continuing about 1,650 feet downstream, turning inland for the last 200 feet to tie into the Route 8 highway embankment near the bridge. About midway of the dike, a floodgate opening will be constructed across the NYNH&H railroad tracks. The embankment of Connecticut Route 8 will serve as the dike linking the downstream end of the dike on the Housatonic River and the downstream end of the Naugatuck River protective works. A protective blanket of gravel and rock will be placed on the riverward slope and closure will be completed by constructing floodgates at the underpass where the NYNH&H railroad passes under the highway. Protection along the Naugatuck River will consist of an earth dike starting at Route 34, extending upstream about 3,300 feet, and tying into the downstream end of the Ansonia-Derby Local Protection Project. A pumping station will be constructed near the Derby sewage treatment plant where the Housatonic dike ties into the Route 8 embankment.

b. Housatonic River watershed. The Housatonic River watershed, shown on plate 1-1, covers an area above its mouth in Long Island Sound, of 1,949 square miles in western portions of Connecticut and Massachusetts and eastern New York. The area, roughly elliptical in shape and oriented in a north-south direction, has a maximum length and width of 98 and 35 miles, respectively. The watershed is hilly with elevations varying from near mean sea level to a maximum of 2620 feet msl along the northern watershed divide. The numerous lakes and ponds scattered throughout the basin have a modifying effect on minor floods, but generally little influence on major events.

The Housatonic River flows in a southerly direction for 145.0 miles from its origin in the Berkshire Hills near Washington Station through Massachusetts and Connecticut to its mouth in Long Island Sound. The main stem falls about 960 feet with an average slope of 7.3 feet per mile. The river is a tidal estuary from Long Island Sound to Derby and Shelton, Connecticut. Principal tributaries are the Naugatuck, Ten Mile, Shepaug, Pomperaug and Still Rivers. The Naugatuck River, the largest of the tributaries, enters the Housatonic at Derby.

c. Naugatuck River watershed. The Naugatuck River watershed, located entirely within the western part of Connecticut, is about 50 miles long with a maximum width of 12 miles and a total drainage area of 312 square miles. The river originates just south of the Massachusetts line in the town of Norfolk at an elevation of approximately 1500 feet msl and flows in a southerly direction joining the Housatonic River in its tidal reach in Derby, about 12 miles from Long Island Sound. The Naugatuck River is a rapidly flowing stream with its several relatively short steep tributaries conducive to rapid runoff and quick flood development.

3. CLIMATOLOGY

a. General. The Housatonic basin has a variable climate which frequently experiences periods of heavy precipitation produced by local thunderstorms and larger weather systems of tropical and extratropical origin. The basin lies in the path of prevailing "westerlies" which generally travel across the country in an easterly or northeasterly direction, producing frequent weather changes. The southern portion of the basin, due to its proximity to the Atlantic Ocean and Long Island Sound, escapes the severity of cold and depth of snowfall experienced in higher elevations in the northern part of the basin.

b. Temperature. Average monthly temperatures in the Housatonic River basin vary widely throughout the year. The mean annual temperature is approximately 47° Fahrenheit, ranging from about 50° F. near the coast to about 44° F. in the headwaters. Extremes in temperature range from occasional highs of 100° Fahrenheit to lows of minus 10° F. in the southern part of the basin and minus 20° F. in northern areas. Freezing temperatures can be expected from the middle of November until the end of March. Tables of mean, maximum and minimum temperatures at various stations in the basin can be found in the following reports: Housatonic River Basin, Report on Review of Survey for Flood Control, 13 September 1963 and Ansonia-Derby Local Protection, Design Memorandum No. 1, Hydrology and Interior Drainage, April 1965, approved June 1965.

c. Precipitation. The mean annual precipitation over the Housatonic River watershed is about 46 inches. The average annual precipitation varies over the basin probably due to orographic influences from less than 42 inches in an area east of Candlewood Lake to more than 55 inches at higher elevations along the eastern boundary. The annual precipitation is uniformly distributed throughout the year, however, monthly extremes range from a high of more than 23 inches in August 1955 to less than 0.20 inch on several occasions. Mean, maximum and minimum monthly precipitation for several stations in the basin are tabulated in the above referenced reports.

d. Snowfall. The average annual snowfall over the watershed varies from about 35 inches near the coast to over 80 inches in the headwater region. Snow cover reaches a maximum depth in March with water content often 4 to 6 inches. Moderately high springtime discharges occur frequently as a result of melting snow, but runoff from this source has been insufficient during the period of record to cause a major flood. The volume of flood runoff resulting from snowmelt and concurrent rainfall would likely exceed the volume resulting from heavy rainfall alone. However, the peak flow generally is of lesser magnitude than one resulting from an intense summer-type storm.

e. Storms. The Housatonic River watershed has experienced storms of four general types, namely: (1) extratropical continental storms which move across the basin under the influence of "prevailing westerlies," (2) extratropical maritime storms which originate and move northward along the eastern United States coast, (3) storms of tropical origin, some of which attain hurricane magnitude, and (4) thunderstorms produced by local convective activity or by more general frontal activity.

The most severe storms have been of tropical origin which occur during late summer and early autumn. The five notable recent storms in the Housatonic River basin occurred in March 1936, September 1938, December 1948, and August and October 1955. Of these, the storms of September 1938 and August and October 1955 were of tropical origin. The August 1955 storm, accompanying hurricane Diane, dumped about 13 inches in 48 hours in the upper part of the Naugatuck River watershed. The October

1955 storm produced 12 inches of rain during the 72-hour storm period over parts of the Housatonic basin. A more detailed discussion of recent storms in the basin is included in "Housatonic River Basin, Review of Survey for Flood Control," 13 September 1963.

4. DISCHARGE RECORDS

The U. S. Geological Survey (USGS) has published records of river stages and streamflows at 23 gaging stations in the Housatonic River basin for various periods of time since 1900. Average annual runoff in the basin is equivalent to 26 inches from the drainage area. This represents about 57 percent of the average annual precipitation, with one-third of the annual runoff normally occurring during the months of March and April.

Pertinent flow data at gaging stations on the Housatonic and Naugatuck Rivers are summarized in table 1-1. Mean daily discharges of the Housatonic River at the USGS gage at Stevenson, Connecticut and the Naugatuck River at Naugatuck for the periods of record are shown on plates 1-14, 1-15, 1-16 and 1-17.

5. HISTORY OF FLOODS

a. General. Flood history of the Housatonic and Naugatuck Rivers demonstrate that floods may occur any season of the year. Inundation may result from intense rainfall over the watershed or from rainfall in conjunction with melting snow such as occurred during the event of March 1936. The more critical floods have developed from rainfall alone when intensity of the rainfall and antecedent conditions rather than total volume determined the magnitude of the flood peaks. This was evident in the events of August and October 1955.

b. Floods of record. The Housatonic River basin has experienced five major floods within the past 30 years which are briefly described in the following paragraphs. Respective discharges of the Housatonic and Naugatuck Rivers at Derby and concurrent tide conditions are listed in table 1-2.

(1) March 1936. The March 1936 floods which resulted from two storms, 9-13 and 16-22 March, produced separate floods. Although rainfall in each storm averaged approximately 3 inches over the basin, peak flows were much greater for the first event due to two basic factors: (a) most of the rainfall in the first storm fell within 24 hours, while the second involved a 48-hour period, and (b) the first flood was augmented by snowmelt from higher elevations and minor ice jams.

(2) September 1938. The storm which produced the flood commenced with light rain, gradually increased in intensity over a 4-day period and ended with a heavy downpour associated with the hurricane that struck New England on 21 September. The rainfall pattern was especially conducive to high peak discharges due to filling of ponds,

TABLE 1-1

STREAMFLOW RECORDS

Location	Drainage Area (sq.mi.)	Period of Record	Mean	Discharge (CFS) Maximum	Discharge (CFS) Minimum
Housatonic River near Great Barrington, Mass.	280	1913-1966	509	12,200 1/1/49	1.0
Housatonic River at Falls Village, Conn.	630	1912-1966	1043	23,900 11/1/49	-*
Housatonic River at Gaylordsville, Conn.	994	1940-1966	1545	51,800 8/19/55	30
Housatonic River at Stevenson, Conn.	1545	1928-1966	2476	75,800 10/16/55	-*
Naugatuck River near Thomaston, Conn.	101	1959-1966	144	5,140 3/31/60	6.6
Naugatuck River near Naugatuck, Conn.	246	1918-1924 1929-1955	470	106,000 8/19/55	24
Naugatuck River at Beacon Falls, Conn.	261	1918-1924 1928-1966	461	106,000 8/19/55	40

* No flow at times (result of regulation)

TABLE 1-2

MAJOR FLOODS
HOUSATONIC AND NAUGATUCK RIVERS

Date of Flood	Water Surface Elevation at Division Street Bridge (feet,msl)	Contribution to Maximum Discharge in Housatonic River (cfs)			Water Surface Elevation at Shelton, Conn. (feet,msl)	Concurrent Tide Condition at Derby, Conn.
		Naugatuck River	Housatonic River	Total		
Mar 1936	21±	27,000	60,000	87,000	18.0	-
Sept 1938	21.3	30,000	60,000	90,000	19.6	Abnormal*
Dec 1948	18.8	32,000	50,000	82,000	17.2	Near normal high
Aug 1955	27.9	112,000	40,000	152,000	21.0	Normal high
Oct 1955	23.8	40,000	75,000	115,000	21.0	Abnormal**

* Abnormal high tide due to hurricane occurred 21 September 1938 at 8 P.M. Maximum discharge occurred 22 September at 1 A.M. Maximum stage recorded concurrently with abnormal high tide.

** Stages of Housatonic River at Devon, Connecticut near the mouth remained 2 to 3 feet above predicted tides throughout the flood. Maximum river stage occurred during abnormally high predicted low tide.

lakes and swamps and satisfying of initial soil moisture deficiencies before the intense rainfall occurred. Moreover, rainfall during the previous month was heavier than normal, thereby reducing the initial storage and infiltration losses.

(3) December 1948. The "New Year's" flood was produced by a cyclonic storm of continental origin. Rain fell on partially frozen ground and ranged up to 10 inches over portions of the Housatonic River basin. Snowmelt, a minor contributing factor early in the flood, had little effect on the magnitude of the peak discharges.

(4) August 1955. The August 1955 storm produced the flood of record on the Naugatuck River. It also would have been the record flood on the Housatonic River except for the Shepaug dam which had just been completed and the storage provided by Lake Lillinonah. Between 11 and 15 August, hurricane Connie brought 4 to 8 inches of rainfall in the basin, but very little runoff occurred due to the unusually dry antecedent conditions. However, when hurricane Diane produced record amounts of precipitation, between 10 and 13 inches, on regions previously saturated by the Connie rainfall, runoff of record proportions occurred. Most of the rain fell in a 24-hour period between 7 A.M. 18 August and 7 A.M. 19 August 1955. Failure of many dams and bridges contributed substantially to peak discharges.

(5) October 1955. The flood, occurring as the result of the storm of 14-17 October 1955 which produced 5 to 10 inches of precipitation in the lower basin, was confined to southwestern Connecticut and western Massachusetts. It was the second largest flood of record on the lower Naugatuck River and the flood of record on the lower Housatonic River. Abnormally high tides during the event contributed to flood stages in the Derby area.

6. FLOOD FREQUENCY

Frequency analyses were made in accordance with procedures described in ER 1110-2-1450, "Hydrologic Frequency Estimates," dated 10 October 1962. A skew coefficient of 1.0 was adopted for all stations in the basin. Discharge-frequency curves developed for the Housatonic River at Stevenson and the Naugatuck River at Ansonia, and a derived curve for the Housatonic at the confluence of the Naugatuck are shown on plate 1-8.

7. ANALYSIS OF FLOODS AT DERBY

a. General. Flood stages in Derby near the confluence of the Housatonic and Naugatuck Rivers are produced by total concurrent flood discharges from the two rivers and the condition of ocean tides in Long Island Sound. Table 1-2 shows a tabulation of relationships between discharge, stage, and coastal tides during recent major floods. Plate 1-9 shows discharge rating curves for the Housatonic River at Shelton, Connecticut below the confluence of the Naugatuck River for normal and abnormal tide conditions in Long Island Sound.

b. Flood development. Due to the large amount of natural valley storage, the upper Housatonic basin, principally above the Massachusetts state line, contributes little to flood peaks at Derby. As a result maximum flows on the Housatonic at Derby are largely produced by the drainage area below the Connecticut-Massachusetts line and peak flows from this area tend to coincide with the rapid development of floods on the Naugatuck River. Relative timing of discharges from the two rivers is demonstrated by flood hydrographs for the two 1955 floods shown on plates 1-4 and 1-5.

8. EFFECT OF RESERVOIRS

a. Housatonic River. The numerous lakes and ponds scattered throughout the lower Housatonic watershed above Derby have a modifying effect on minor floods and generally little effect on major events. One exception is Candlewood Lake Reservoir on Rocky River. Due to the large amount of surcharge storage at this reservoir, there is negligible contribution to downstream flood peaks from this 40.4 square mile drainage area.

Lake Lillinonah provided highly effective flood control storage during the record flood of August 1955 since it was empty and impounded a significant part of the flood. However, no reduction can be expected in the future because of the operation required during floods to minimize backwater effects.

b. Naugatuck River. The flood control plan for the Housatonic River basin includes 7 flood control dams and reservoirs in the Naugatuck River watershed, namely, Thomaston, Hall Meadow Brook, East Branch, Northfield Brook, Black Rock, Hancock Brook and Hop Brook. At present all dams are completed with the exception of Black Rock and Hop Brook which are under construction. The effect of this system of reservoirs on past floods is shown in table 1-3 and plates 1-4 and 1-5. In the design of the Derby Local Protection Project it is assumed that this system of reservoirs is complete and regulated as outlined in the Master Manual of Reservoir Regulation for the Housatonic River basin, dated June 1964. In the future peak discharges on the Naugatuck will be produced by runoff from the remaining 160 square mile uncontrolled drainage area in the basin.

9. STANDARD PROJECT FLOODS

a. General. Standard project floods were determined for the Housatonic River at Derby above the mouth of the Naugatuck River, the Naugatuck River at Derby, and the concurrent flood in the Housatonic River in the tidal reach below the mouth of the Naugatuck River. Development included derivation of unit hydrographs and the application thereto of standard project storm rainfall, using procedures described in Civil Engineer Bulletin 52-8.

TABLE 1-3

EFFECT OF PROPOSED NAUGATUCK RIVER RESERVOIR SYSTEM IN REDUCING RECENT MAJOR FLOODS AND STANDARD PROJECT FLOOD - NAUGATUCK RIVER AT DIVISION STREET AND AT CONFLUENCE WITH HOUSATONIC RIVER, DERBY, CONNECTICUT

Flood	Naugatuck Discharge Natural (cfs)	Naugatuck Discharge Modified* (cfs)	Stage At Division Street Natural (msl)	Stage At Division Street Modified (msl)	Stage Confluence with Housatonic River Natural (msl)	Stage Confluence with Housatonic River Modified (msl)	Tide
Sept 1938	30,000	15,000 (est)	21.3	19.6	19.6	18.8	Abnormal
Dec 1948	32,700	15,600	18.8	17.4	17.2	16.0	Normal
Aug 1955	112,000	54,000	27.9	22.6	21.0	18.4	Normal
Oct 1955	40,000	23,000 (est)	23.8	21.4	21.0	20.5	Abnormal
SPF	148,000	75,000	33.0 (est)	30.0	28.3	26.0	Abnormal

* The proposed system includes the following reservoirs: Thomaston, Hall Meadow Brook, East Branch, Northfield Brook, Black Rock, Hancock Brook and Hop Brook

b. Unit hydrograph analysis. Unit hydrographs were developed for the Housatonic River at the Stevenson USGS gage for the net drainage area of 873 square miles, excluding the sluggish area above the Falls Village USGS gage and the noncontributing drainage area of Candlewood Lake, the 37 square mile local drainage area from Stevenson to Derby, and the Naugatuck River at Derby for the 160 square mile uncontrolled drainage area in that river basin.

The 6-hour unit hydrograph at Stevenson was derived from floods of record, namely, November 1932, December 1948 and August 1955. The unit hydrograph for the local area between Stevenson and Derby was computed from a previously developed unit hydrograph for the Pomperaug River at Southbury. The Naugatuck 6-hour unit hydrograph was taken from previous standard project flood analysis with the system of reservoirs in operation, as reported in the "Interim Report on Review of Survey, Housatonic River Basin, Naugatuck River," dated June 1958. The three adopted 6-hour unit hydrographs are shown on plate 1-6.

c. Housatonic River discharge below mouth of Naugatuck River. The standard project storm rainfall excess for the combined net drainage area of 1,070 square miles was applied to the adopted unit hydrographs, assuming an infiltration rate of 0.05 inch per hour. The SPF hydrograph at Stevenson was then lagged 2 hours to Derby and combined with the other two. The resulting standard project flood hydrograph for the Housatonic River below the mouth of the Naugatuck, including 6,000 cfs added as the contribution from the drainage area above Falls Village, has a peak discharge of 220,000 cfs. This peak flow is about 20 percent higher than the estimated peak of the August 1955 flood without the effect of Lake Lillinonah but modified by the system of reservoirs in the Naugatuck basin.

d. Housatonic River discharge above mouth of Naugatuck. A standard project flood for the Housatonic River above the Naugatuck was derived by centering the standard project storm over the net contributing drainage area of 910 square miles, assuming an infiltration rate of 0.05 inch per hour. The resulting standard project flood hydrograph plus the 6,000 cfs contribution from the area above Falls Village produced a peak discharge at Derby of 198,500 cfs. The estimated peak of the August 1955 flood at this location without the effect of Lake Lillinonah was 125,000 cfs.

e. Naugatuck River discharge at Derby. The standard project flood in the Naugatuck, modified by the system of flood control reservoirs, was previously developed and is described in the Interim Report on Review of Survey, Housatonic River Basin, Naugatuck River, dated June 1958. In this analysis the standard project storm was oriented in the lower portion of the Naugatuck River basin to determine the maximum flows at Ansonia and Derby with the proposed system of reservoirs in operation. The resulting standard project flood had a peak discharge of 75,000 cfs.

10. PROJECT DESIGN FLOOD

The Derby project will be designed for the SPF discharge of 198,500 cfs in the Housatonic, 75,000 cfs in the Naugatuck and 220,000 cfs with an abnormal tide at the confluence of the two rivers. Stated in another way, the protective works will be built to an elevation necessary to protect against the severest of the following criteria: (1) the SPF discharge of 198,500 cfs in the Housatonic with a concurrent flow of 21,500 cfs in the Naugatuck (total combined 220,000 cfs) with an abnormal tide in Long Island Sound, and (2) the SPF discharge of 75,000 cfs in the Naugatuck with a concurrent flow in the Housatonic of 145,000 cfs (total combined 220,000 cfs) with an abnormal tide in Long Island Sound.

Maximum flood stages in the Derby area are dependent on flows in the Naugatuck and Housatonic and concurrent tide conditions in the Sound. As noted in table 1-2 abnormally high tides have occurred concurrent with floodflows in the Housatonic and Naugatuck Rivers. It is therefore considered reasonable to assume that the maximum stage in the Derby area would occur with design floodflows coincident with an abnormal tide in Long Island Sound. A starting elevation at the confluence of the two rivers of 26.0 feet msl was derived by applying the peak of the SPF (220,000 cfs) to the rating curve for an abnormal tide at Derby.

11. MODEL STUDY

A hydraulic model study was made at the Waterways Experiment Station in Vicksburg, Mississippi of proposed protection measures and improvements for both the Ansonia-Derby and Derby projects using the above design discharges. The model study was considered necessary due to the complex flow conditions resulting from the combination of abrupt changes in channel section and skewed bridges and bends for which hydraulic losses could not be reliably computed. Results of the model study and selected grades for the dikes and floodwalls will be presented in Design Memorandum 5, Hydraulic Analysis.

PART II - INTERIOR DRAINAGE

12. GENERAL

The proposed system of dikes and walls will intercept runoff from approximately 380 acres of interior area. Land uses in the interior basin are about 40 percent residential, 45 percent commercial and industrial and 15 percent undeveloped. Developments in the higher elevations of the drainage basin are largely residential with high value industrial and commercial property located on the flat flood plain adjacent to the river. Most of the undeveloped area is that portion of the flood plain lying between the NYNH&H railroad and the Naugatuck River and presently used as a stock piling area by a commercial sand and gravel business.

For analysis the total interior basin was divided into 8 subareas. Delineation of the interior drainage areas and drainage facilities to be provided are shown on plate 1-12. Provisions for interior drainage consist of 1 pumping station, 2 pressure conduits, 2 gravity outfalls and an interceptor drain.

13. TOPOGRAPHY

The topography of the residential area is hilly and sloping steeply to the flat flood plain. The steep area comprises approximately 150 acres with the flat flood plain making up the remainder of the interior drainage area. The highest point in the basin is approximately 300 feet msl and lies in the northwesterly corner. The average slope from this point to the flood plain is 8 percent. The flat flood plain in general has a slight slope toward the confluence of the two rivers at the southeasterly corner of the interior basin.

14. DESIGN CRITERIA

The criteria used in the design of the pressure conduits, interceptor storm drains, pumping stations, and gravity outfalls are the same as used for the adjoining Ansonia-Derby project and are as follows:

a. Pressure conduits. Pressure conduit systems shall be designed to intercept and carry a 100-year storm runoff determined by the rational method with rainfall rates from U. S. Weather Bureau Technical Paper 40.

b. Interceptor drains. Interceptor drains along the line of protection collect runoff that would normally flow overland to the river. They will be designed to carry a 10-year storm with the drain running full and discharging by gravity.

c. Pumping stations. Pumping stations will be designed to discharge the runoff produced by a rainfall rate of 1.5 inches per hour against the design river stage. The Island Park pumping station will be built alongside an earth dike requiring that the pump discharge line pass over the top of the dike.

d. Subdrains. The design of seepage flows is based on a flow rate of 0.07 gpm per foot of differential head per foot of dike. This is an approximation based upon incomplete knowledge of the structures and is subject to modification in final design. Maximum subdrain flows will occur with the river at high stage and the discharge will be into the new interceptor drains which are designed for a 10-year storm. The design storm with the river at high stage is considerably less than the 10-year storm, therefore, with maximum flow in the subdrains, the interceptor drains will be flowing less than full.

e. Gravity outfalls. The two gravity outfalls will be designed to discharge a 100-year storm runoff with a normal river stage.

f. Sluice gates. Sluice gates will be installed on all pressure and gravity discharge conduits that pass through the line of protection. The gates will be located on the riverside of the line of protection and will permit emergency closure in the event of conduit failure. Flap gates will also be installed on the outlet ends of all conduits.

15. DRAINAGE SYSTEMS

Location, topography and drainage of the 8 interior drainage areas are discussed in the following paragraphs. A proposed drainage system that will meet the prescribed criteria is presented for each of the 8 areas. Design discharges for all areas are shown in table 1-4. Drainage areas and drainage systems are shown on plates 1-12 and 1-13.

a. Drainage area 1. Area 1 is located northwest of the main business district of Derby on the east side of the Housatonic River. The area is typical of the steep, medium concentrated residential areas of the city with some scattered small business establishments. The watershed, consisting of 21 acres, is approximately 2,100 feet in length with a differential in elevation from 40 to 150 feet msl. The area is serviced by a combined sanitary sewer and storm drain system. During dry weather, sewage flows through a regulator in the vicinity of Bridge Street and First Street and then through an 18-inch line down First Street to the Derby sewage treatment plant. During wet weather a float valve in the regulator closes the 18-inch line and diverts all flow into a 36-inch concrete pipe that discharges into the Housatonic River approximately 390 feet downstream from Bridge Street.

The pattern of overland flow is determined by the area's network of streets, generally running in a southerly direction toward Main Street. Flows exceeding the limited capacity of the existing combined sewers concentrate at the intersection of Main, Bridge and Olivia Streets where they are intercepted by a separate storm drain system. This separate system containing catch basins and drain manholes discharges storm water into the 36-inch concrete overflow pipe and also into a 24-inch concrete pipe that runs down First Street, turns 90° and discharges into the Housatonic River approximately 75 feet downstream of the Bridge Street bridge.

It is proposed to do the following: (1) remove the existing 24-inch drain, (2) construct a new drain manhole at the edge of the Bridge Street bridge on the downstream side and install 15 feet of 36-inch pressure pipe, and (3) install a roadway inlet with grating across the width of First Street in order to insure that overland flow is diverted into the 36-inch pressure pipe. The 36-inch pressure pipe will be designed to discharge, by gravity, rainfall runoff from a 100-year storm with the river at low stage. The total flow with this storm will be 57 cfs. Flow from a 10-year storm can be easily handled by the pressure pipe with the river at flood crest due to the availability of a maximum differential head of 8 feet.

TABLE 1-4

INTERIOR DRAINAGE DISCHARGE AND RATIONAL FORMULA DATA

	Drainage Areas										
	1	2	3	4A	4B	4C	5	6	7	8	
Drainage Area (acres)	21	31	33	22	46	43	50	51	17	60	
Infiltration Factor (C)	0.5	0.5	0.8	0.5	0.5	0.5	0.5	0.2* 0.8**	0.5	0.5	
Time of Concentration (Tc)	20	30	40	35	35	35	35	30	35	30	
100-Year Rainfall (inches/hours)	5.4	4.5	3.9	4.2	4.2	4.2	4.2	4.5	4.2	4.6	
10-Year Rainfall (inches/hours)	4.0	3.3	2.8	3.0	3.0	3.0	3.0	3.3	3.0	3.2	
100-Year Discharge (cfs)	57	70	103	46	97	100	105	46* 184**	36	140	
10-Year Discharge (cfs)	42	51	63	33	69	72	75	34* 136**	25	95	
Discharge for 1.5 (inches/hours) Rainfall Rate	16	23	40	17	35	36	37	15* 61**	13	45	
	Design Discharges (cfs)										Total
Housatonic Pressure Conduit	57										57
Housatonic Gravity Outfall		70	103	46	97		105		36		457
Naugatuck Pressure Conduit										140	140
Naugatuck Gravity Outfall								184	36		220
Island Park Pump Station		23	40	17	35	36	37		13		200

* Undeveloped
** Developed

b. Drainage area 2. This area contains part of the business district and the remainder is north of the business district and adjacent to area 1. It is a residential and business area very similar to area 1. The watershed, consisting of 31 acres, is approximately 2,100 feet in length with a differential in elevation from 40 to 130 feet msl. Streets form the watershed boundaries and the area has a combined sanitary sewer and storm drain system. Beginning on Caroline Street, 400 feet south of Main Street, the old combined sewer is now intercepted by a new 18-inch pipe that carries dry weather flow to the Derby sewage treatment plant. This interception has been accomplished by the construction of a new manhole and connector pipe adjacent to an old manhole and by modifications to the old manhole. During wet weather all flow will bypass the interceptor and flow into the old system by means of a "leaping weir" constructed in the old manhole. The old system consists of a 42-inch pipe that discharges into the Housatonic River approximately 65 feet upstream from the railroad bridge.

The pattern of overland flow is determined by the area's network of streets and generally flows in a southeasterly direction to the intersection of Caroline and Main Streets and then down Caroline Street into area 3. The 42-inch pipe has a capacity more than adequate to carry the runoff from both a 10- and 100-year storm. It is proposed to construct a drain manhole with grate, as part of the proposed storm drain along the landside toe of the dike, to intercept the 42-inch pipe and any surface runoff from area 2 coming into area 3.

c. Drainage area 3. Area 3 is a low lying area bordered by Route 8, Main Street and the Housatonic River. It is a flat flood plain that has been filled with debris and sanitary land fill and is now 75 percent developed with commercial and industrial buildings and parking areas and contains 33 acres. Little if any interior drainage structures exist within the area and surface runoff flows overland to the Housatonic River. It is proposed to construct a storm drain along the landside toe of dike to intercept surface runoff. The storm drain system will begin at the floodwall approximately 260 feet south of Bridge Street and run southeasterly to a pumping station and an 8 x 8 foot gravity outfall adjacent to the Derby sewage treatment plant.

d. Drainage areas 4A, 4B and 4C. This area is a long, narrow and complicated drainage area that begins at the intersection of Route 8 and Main Street and extends in a northerly direction approximately 1 mile to a plateau. The area is serviced by a combined sanitary sewer and storm drain system that extends into area 8 and has a very limited capacity. The area is bisected by Route 8 and the railroad which cuts off the natural overland flow path toward the Naugatuck River. For design purposes the area has been subdivided into 3 sections designated as areas 4A, 4B and 4C.

(1) Area 4C. This is a predominantly residential area located on a plateau. It is bordered by Route 8 and contains about 48 acres.

Surface runoff will flow either toward Route 8 and be intercepted by storm drains in Route 8 and discharged into a ditch in area 5, or will flow on the streets following the course of the combined sewer into Seymour Avenue and area 4B. The drainage area, consisting of 48 acres, is approximately 2,200 feet in length with a differential in elevation from 150 to 300 feet msl.

Drainage from this area does not contribute to the peak 10 and 100-year discharge at the Island Park gravity outlet due to the estimated 1-hour travel time. Peak discharges are dependent on the local areas with a 40-minute time of concentration. This area will contribute 36 cfs to the pumping station based on the adopted criteria for establishing pumping station capacities.

(2) Area 4B. This area is typical of the steep, medium concentrated residential areas of the city. The drainage area, consisting of 46 acres, is approximately 2,700 feet in length with a differential elevation from 50 to 150 feet msl. Although the area is serviced by a combined sewer system little if any storm water enters the system, due to its limited capacity, but flows overland easterly to Seymour Avenue and then down Water Street to area 4A.

(3) Area 4A. Area 4A is a low area bordered by Route 8, Main Street and Water Street. It is a flat, flood plain that is almost completely occupied by the Farrell Company buildings and parking areas and contains 22 acres. The area is serviced by a number of drain inlets and a 48-inch concrete pipe which runs in a southerly direction parallel to Route 8 and discharges into the Housatonic River approximately 160 feet upstream from the centerline of Route 8. The 48-inch pipe begins with a junction box located on the Farrell Company property approximately 100 feet left of centerline of Route 8. Normally, the surface runoff from a 10-year storm reaching the 48-inch pipe would be the runoff from areas 4A, 4B, 5 and 7 and total 202 cfs. At present only the surface runoff from areas 4A and 4B reaches the 48-inch pipe and totals 102 cfs. This amount can be carried by the 48-inch pipe, by being slightly surcharged, which has a capacity of 95 cfs flowing full. Surface runoff from areas 5 and 7 cannot enter area 4A and the 48-inch pipe because the system of pipes and ditches are now blocked by land filling operations and therefore runoff ponds and remains in these areas. It is assumed that at sometime in the future ponding will be relieved, the ditches and pipes will be maintained and the total runoff of 202 cfs will reach the proposed pumping station and gravity outlet and therefore the design will be based on this assumption.

e. Drainage area 5. Area 5 is located west of the Naugatuck River. It is a flat flood plain that slopes gently toward the Naugatuck River. The area is approximately 40 percent developed as a shopping center which occupies the northern part of the watershed. The watershed, containing 50 acres, drains easterly toward the Naugatuck River but surface runoff is cut off from reaching the river due to the construction of Route 8. The shopping center has an extensive drain inlet and pipe system that carries surface runoff in a southerly direction crossing under Route 8 through a 36-inch culvert that discharges into a ditch. This ditch then carries runoff in a southwesterly direction under Route 8 and a railroad spur track through a second 36-inch culvert which discharges into a second ditch. This second ditch then carries runoff southerly along Route 8 and then southwesterly under Route 8 through a third 36-inch culvert and discharges into the junction box and 48-inch pipe in area 4A.

At present the outlet of the second 36-inch culvert is blocked by debris and land fill, thereby causing runoff to pond in an area west of Route 8 and the Pershing Drive connector. Also blocked by debris are parts of the second ditch and the inlet to the third 36-inch culvert which prevents all runoff from entering the junction box in area 4A. It is assumed that at some future date this situation will be relieved and the total runoff will then reach the pumping station and gravity outlet at the Housatonic River. These structures will be designed on this basis.

f. Drainage area 6. This area is located on the west bank of the Naugatuck River between the river and the railroad tracks. The watershed, containing 51 acres, is a flat, flood plain that drains easterly to the river. The area is mostly undeveloped with part of the northern end being occupied by an outdoor movie and the remainder of the area by a sand and gravel operation. This operation includes the stockpiling of sand and gravel and removal of some excavation which means a constantly changing topography. Also included in the operation are three manmade ponds which collect and store surface runoff and ground water. Little, if any, surface runoff reaches the river due to these ponds, which are below the average river elevation, and to materials stockpiled by the property owner. Due to these conditions, it is impractical to construct either a toe drain, an interior drainage system or a pumping station without completely changing the character of the area. Therefore, it is proposed to construct a 6 x 6 foot gravity outlet only which will be equipped with a flap gate on the outlet end and a sluice gate located on the riverside of the dike to permit emergency closure. The outlet through the dike, will have a capacity to discharge the 100-year peak runoff with normal river stage. During high river stages, interior runoff will be allowed to pond as it does at present. A 10-year, 12-hour rainfall over areas 6 and 7 during high river stages would produce 25 acre-feet of ponding adjacent to the dike. Under present topographical conditions, this would represent ponding to elevation 8.5 msl. The start of damage under existing conditions is about elevation 12.0 msl.

g. Drainage area 7. Area 7 is located west of the Naugatuck River between the railroad tracks and Route 8. It is a flat flood plain that is 50 percent developed with the northern half occupied by the Charlton Press Company, a bowling alley and a miniature golf course. This developed area is serviced by a storm drain system that carries surface runoff in a southwesterly direction and discharges into a ditch just beyond the miniature golf course. The ditch then carries runoff in a southerly direction, adjacent to Pershing Drive, and enters the 36-inch culvert that crosses Route 8 and the railroad spur track. At present, the southern half of area 7 that encompasses the ditch is a low area with existing ground elevation below the level of both the railroad tracks and Route 8. This area is presently changing topographically due to land filling operations which have blocked part of the ditch and the entrance to the 36-inch culvert, thereby causing runoff to be trapped in a section of the ditch.

Area 7, containing 17 acres, is situated about 10 to 15 feet above the normal level of the Naugatuck River and the area could be drained to the Naugatuck River by piping under the railroad or it could continue to drain to the Housatonic River via the existing system. It would be difficult to speculate as to the eventual drainage system due to unknown land use plans for the area and the extent of the land filling. Therefore, the runoff from a 100-year storm totaling 36 cfs will be included in the design of the gravity outlets at both the Naugatuck and Housatonic Rivers.

h. Drainage area 8. Area 8 contains approximately 60 acres and is located between Route 8 and area 5. It is a steep, residential area that drains easterly toward the Naugatuck River. At present, runoff from the area is collected in a natural steep channel which is intercepted at the foot of the slope, adjacent to the Valley Shopping Center, by the 36-inch culvert that carries flow southerly under Route 8 and into area 5.

It is proposed, under the Ansonia-Derby Local Protection Project, to intercept this runoff in the area of the shopping center with a drain inlet and a 48-inch pressure conduit and to carry flow easterly under Pershing Drive, the railroad and the proposed dike and discharge into the Naugatuck River.

16. PUMPING STATION

The Island Park pumping station is included as a component of the local protection project and is considered a necessity for the following reasons:

a. The flood plain area adjacent to the Housatonic River does not lend itself to the development of a large ponding area due to its low elevation with respect to the river. Long duration ponding, causing adverse ground water conditions, would result during periods when flow through a gravity outlet was precluded by high river stages.

b. The city presently has a combination sanitary-storm drainage system in the upper residential area which drains to a treatment plant at the location of the pumping station. Temporary ponding of drainage from this system during periods of high river stage would not be desirable.

c. The city of Derby has limited space for future expansion and because of the potentially high value of this flood plain land for development, it is considered infeasible to reserve areas for temporary storage of interior runoff.

The proposed pumping station will serve subareas 2, 3, 4, 5 and 7 and will pump effluent from the Derby sewage treatment plant during high river stages.

17. HYDROLOGIC ANALYSIS

a. River stage and discharge frequencies. A modified stage frequency curve for the Housatonic River adjacent to the Island Park pumping station and the Naugatuck River at the proposed gravity outfall is shown on plate 1-10. During the evacuation of stored flood runoff in the upstream reservoirs the discharge in the Naugatuck will be maintained at about 9,000 cfs for sustained periods of time. Discharge frequency curves for the Naugatuck, modified by upstream reservoirs, indicate that a discharge of 9,000 cfs will have an average frequency of occurrence of about once in 3 years. A comparable flow in the Housatonic would be 30,000 cfs. The design sump level for pump activation to prevent interior flood damage will be at or near the river stage produced by these concurrent flows with a normal tide.

b. Coincidence of interior runoff and river stage. Plate 1-11 shows the rainfall rates in the Derby area concurrent with high river stages in the Naugatuck River during past floods, namely, August and October 1955, December 1948 and September 1938. During all 4 floods it would have been necessary to activate the pumps had the local protection project been in existence. The maximum hourly rainfall rates during the period of high river stage were 0.67 inch in 1938 flood, 0.20 inch in 1948 flood and just over 1 inch in both the October and August floods of 1955.

Analysis of flow records indicate that the rivers are above design pump level for pump activation about 0.3 percent of the time. Based on procedures outlined in EM 1110-2-1410 and rainfall data from U. S. Weather Bureau Technical Paper 40 the recommended storm for the design of pumping stations for a "class I" urban area would have a rainfall rate of approximately 0.7 inch per hour. However, in 30 years of record the area has twice experienced rainfall rates of 1.0 inch per hour coincident with high river stage. Considering experienced conditions and the flashy nature of the rivers, a design storm of 1.5 inches per hour, or 50 percent greater than the maximum experienced was adopted.

18. DAMAGE POTENTIAL IN PROTECTED AREAS

The existing industrial and commercial developments on the flood plain are presently subject to short duration flooding from high intensity rainfall due to rapid concentration of runoff from the steep slopes accumulating on the flood plain. The damage potential cannot be determined precisely because the complex overland flow pattern and the head discharge relationships of the existing drainage structures may be substantially affected by ice and other debris during critical flood periods. Also the effectiveness of future drainage improvements by the city could improve the situation markedly.

The proposed drainage systems to be constructed with this project will prevent any increase in the flood potential of the low lying industrial and commercial areas. However, the existing condition of infrequent shallow flooding in the streets and on the highly industrial and commercialized flood plain during short duration, high intensity rainfall will not be completely eliminated unless the city makes significant improvements in the interior drainage system. It is estimated that with the proposed drainage system, during maximum 100-year rainfall intensities, depth of flow in streets and other natural waterways might reach depths of 6 inches. Depths of ponding in depressions over present drainage inlets might reach from 1 to 1.5 feet. This flooding would be of relatively short duration, however, probably not exceeding periods of more than 1 to 2 hours. In the highly commercial and industrial areas such flooding is presently experienced and would result in some inconvenience but due to its short duration, it is tolerated with little permanent damage. This level of ponding is considered to be within the limits of ponding level "C" as discussed in EM 1110-2-1410.

Because of the flat topography of the flood plain, depths of flooding from the standard project storm would not be excessive and would be of relatively short duration, varying from 2 to 3 hours. There would be little threat to human life and losses would be relatively minor. It is considered that ponding depths would be well within the limits of stage "D" as described in EM 1110-2-1410.

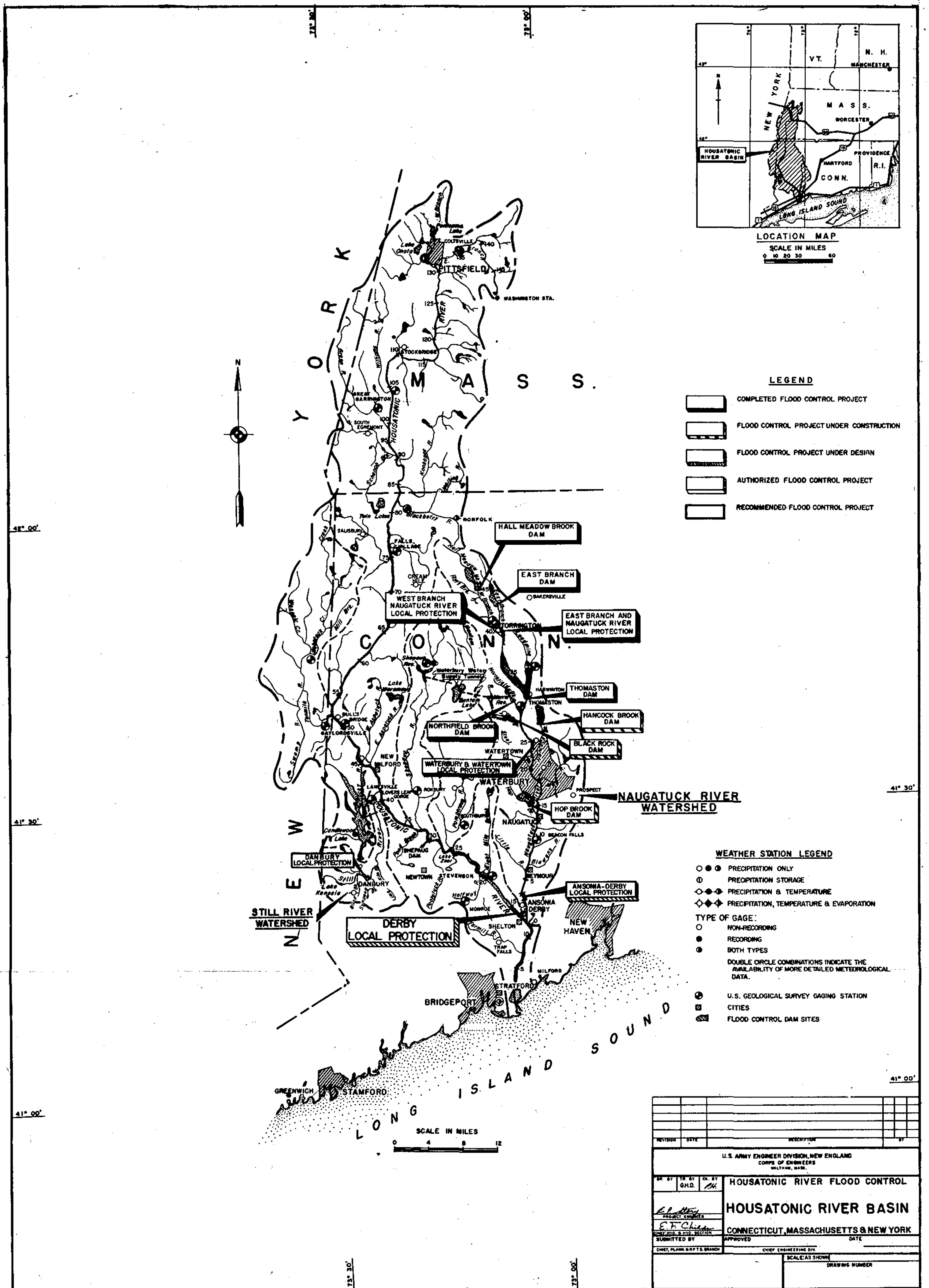

LOCATION MAP
SCALE IN MILES
VT.
N. H.
MANCHESTER
MASS.
WORCESTER
NEW YORK
HOUSATONIC RIVER BASIN
PROVIDENCE
HARTFORD
R.I.
CONN.
LONG ISLAND SOUND
LEGEND
COMPLETED FLOOD CONTROL PROJECT
FLOOD CONTROL PROJECT UNDER CONSTRUCTION
FLOOD CONTROL PROJECT UNDER DESIGN
AUTHORIZED FLOOD CONTROL PROJECT
RECOMMENDED FLOOD CONTROL PROJECT
NEW YORK
MASS.
CONN.
PITTSFIELD
WASHINGTON STA.
STOCKBRIDGE
GREAT BARRINGTON
SOUTH EGREMONT
HOUSATONIC
NORFOLK
SALISBURY
FALLS VILLAGE
HALL MEADOW BROOK DAM
EAST BRANCH DAM
BAKERSVILLE
WEST BRANCH NAUGATUCK RIVER LOCAL PROTECTION
TORRINGTON
EAST BRANCH AND NAUGATUCK RIVER LOCAL PROTECTION
THOMASTON DAM
HANCOCK BROOK DAM
NORTHFIELD BROOK DAM
BLACK ROCK DAM
BULLS BRIDGE
GAYLORDSVILLE
NEW MILFORD
WATERTOWN
WATERBURY & WATERTOWN LOCAL PROTECTION
WATERBURY
PROSPECT
NAUGATUCK RIVER WATERSHED
HOP BROOK DAM
NAUGATUCK
BEACON FALLS
DANBURY LOCAL PROTECTION
DANBURY
NEWTOWN
STEVENSON
SEYMOUR
ANSONIA-DERBY LOCAL PROTECTION
ANSONIA
DERBY
STILL RIVER WATERSHED
DERBY LOCAL PROTECTION
MONROE
SHELTON
NEW HAVEN
MILFORD
STRATFORD
BRIDGEPORT
STAMFORD
GREENWICH
LONG ISLAND SOUND
SCALE IN MILES
WEATHER STATION LEGEND
PRECIPITATION ONLY
PRECIPITATION STORAGE
PRECIPITATION & TEMPERATURE
PRECIPITATION, TEMPERATURE & EVAPORATION
TYPE OF GAGE:
NON-RECORDING
RECORDING
BOTH TYPES
DOUBLE CIRCLE COMBINATIONS INDICATE THE AVAILABILITY OF MORE DETAILED METEOROLOGICAL DATA.
U.S. GEOLOGICAL SURVEY GAGING STATION
CITIES
FLOOD CONTROL DAM SITES
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
HOUSATONIC RIVER FLOOD CONTROL
HOUSATONIC RIVER BASIN
CONNECTICUT, MASSACHUSETTS & NEW YORK
SCALE: AS SHOWN

PLATE NO. I-I

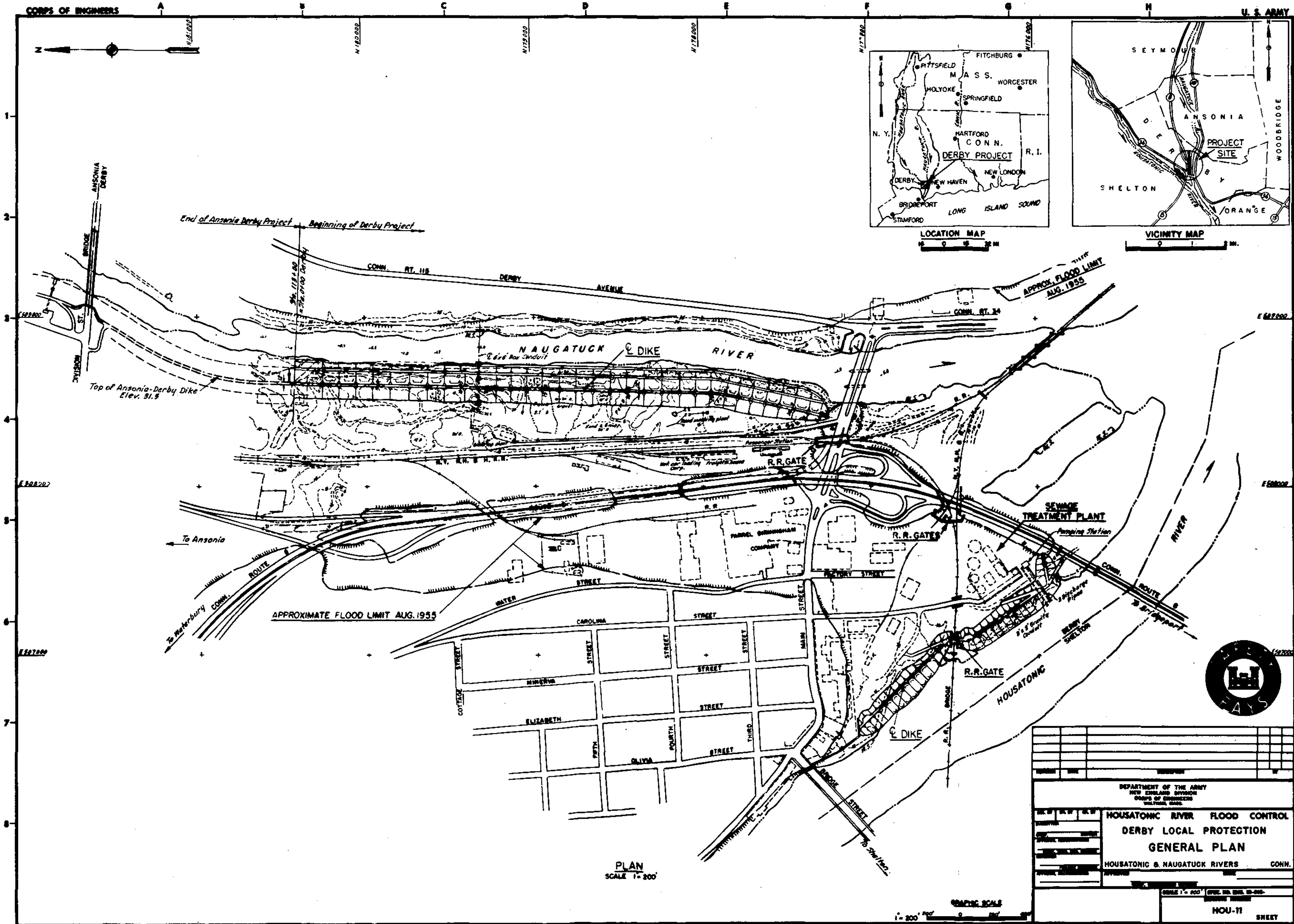
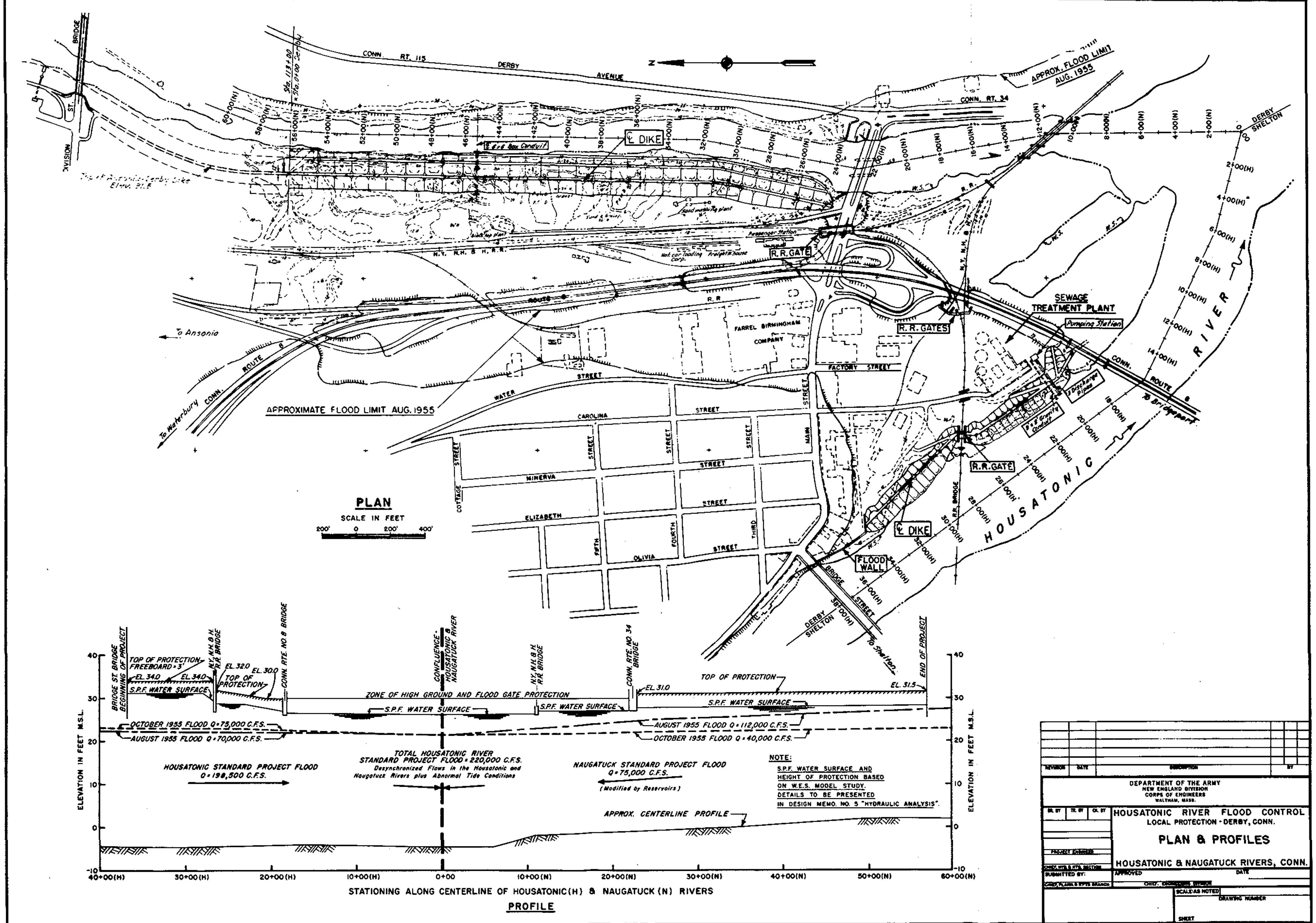

CORPS OF ENGINEERS
U. S. ARMY
LOCATION MAP
FITCHBURG
PITTSFIELD
MASS.
WORCESTER
HOLYOKE
SPRINGFIELD
N. Y.
HARTFORD
CONN.
R. I.
DERBY PROJECT
DERBY
NEW HAVEN
NEW LONDON
BRIDGEPORT
STAMFORD
LONG ISLAND SOUND
VICINITY MAP
SEYMOUR
ANSONIA
DERBY
PROJECT SITE
SHELTON
ORANGE
WOODBRIDGE
End of Ansonia Derby Project
Beginning of Derby Project
CONN. RT. 115
DERBY AVENUE
APPROX. FLOOD LIMIT AUG. 1955
CONN. RT. 34
NAUGATUCK RIVER
℄ DIKE
Top of Ansonia-Derby Dike Elev. 31.5
ANSONIA DERBY BRIDGE
Passenger Station
R.R. GATE
R.R. GATES
SEWAGE TREATMENT PLANT
Pumping Station
To Ansonia
To Waterbury CONN. ROUTE 8
FARREL BIRMINGHAM COMPANY
APPROXIMATE FLOOD LIMIT AUG. 1955
WATER STREET
FACTORY STREET
CAROLINA STREET
MINERVA STREET
ELIZABETH STREET
OLIVIA STREET
COTTAGE STREET
FIFTH STREET
FOURTH STREET
THIRD STREET
MAIN STREET
R.R. GATE
℄ DIKE
R.R. BRIDGE
HOUSATONIC RIVER
DERBY SHELTON
CONN. ROUTE 8 To Bridgeport
BRIDGE STREET
To Shelton
PLAN
SCALE 1" = 200'
GRAPHIC SCALE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
GENERAL PLAN
HOUSATONIC & NAUGATUCK RIVERS CONN.
HOU-11

PLATE NO. 1-2



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER FLOOD CONTROL
LOCAL PROTECTION - DERBY, CONN.

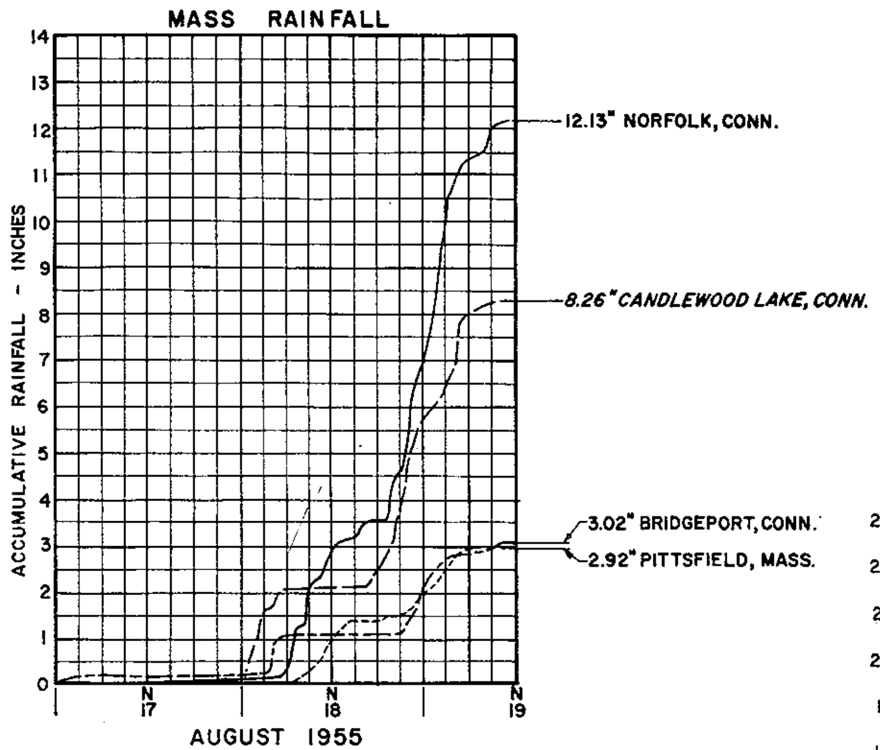
PLAN & PROFILES

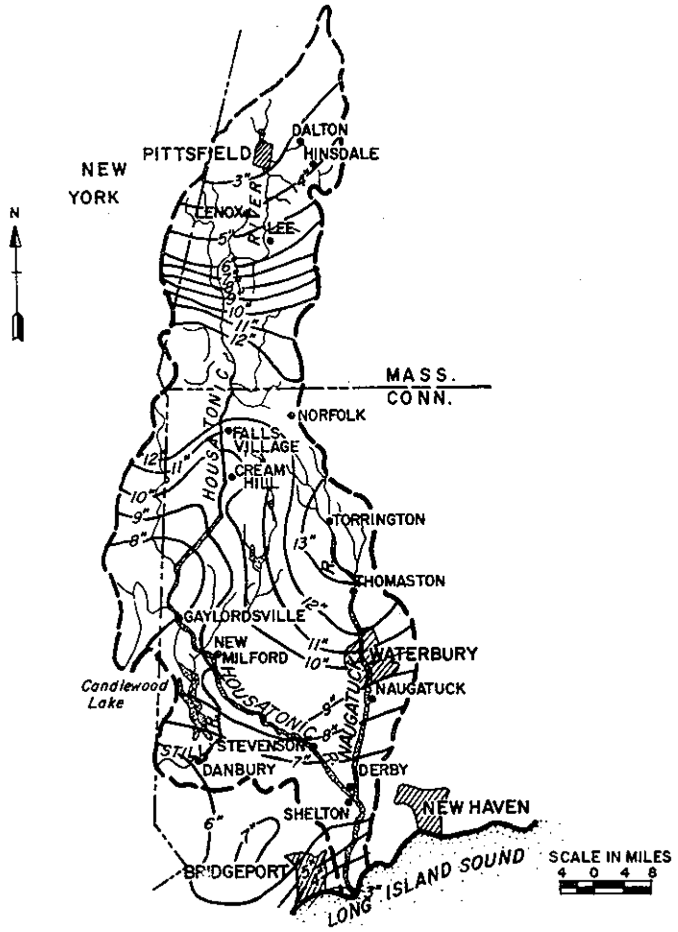
HOUSATONIC & NAUGATUCK RIVERS, CONN.

SCALE: AS NOTED

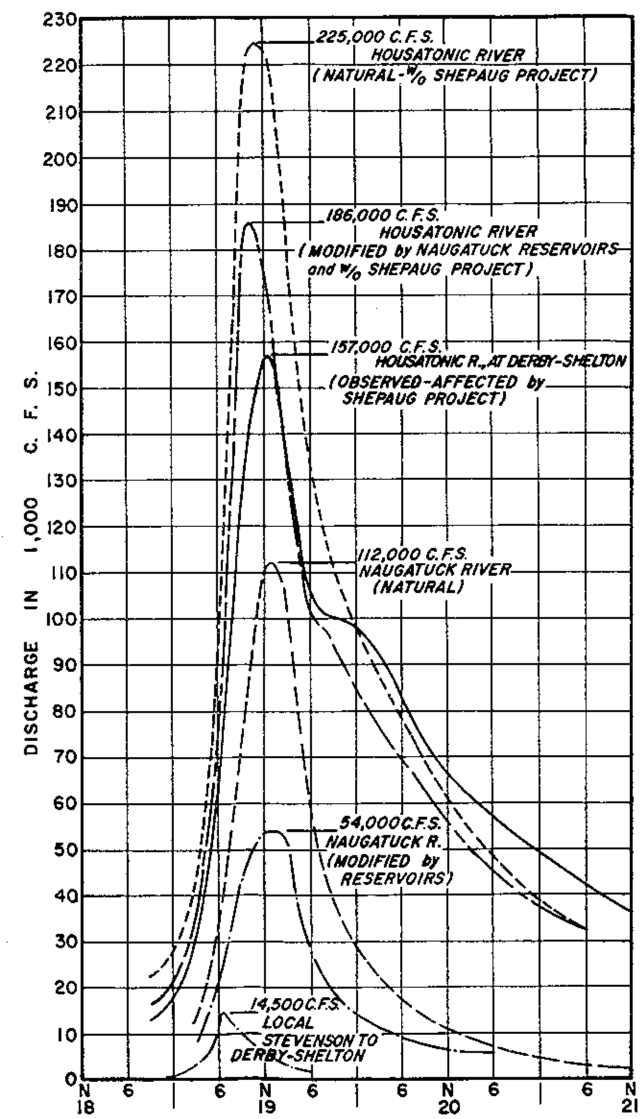
PLATE NO. I-3

MASS RAINFALL

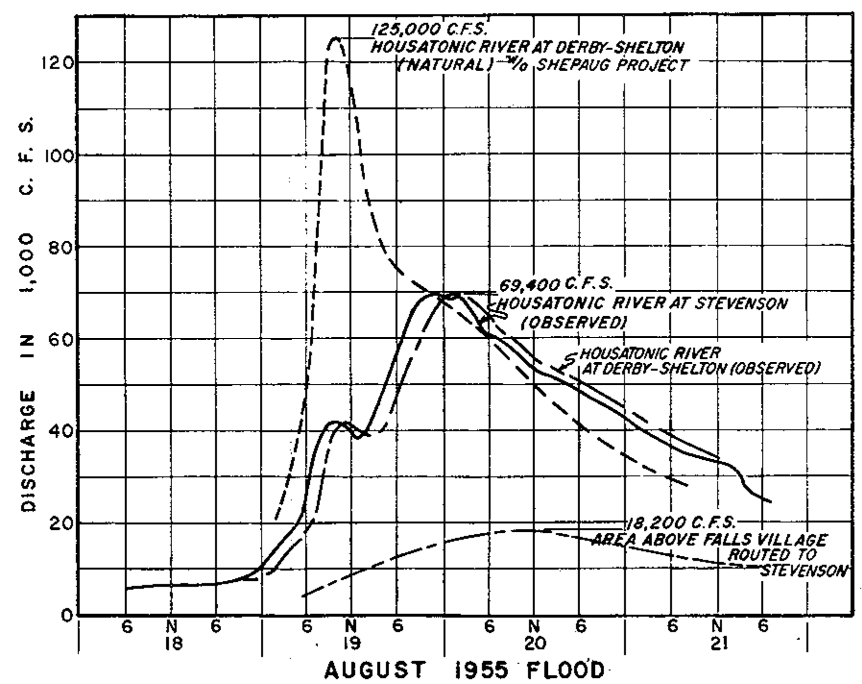




ISOHYETAL MAP
STORM OF AUGUST 17 - 20, 1955
(HURRICANE "DIANE")



AUGUST 1955 FLOOD
DERBY - SHELTON

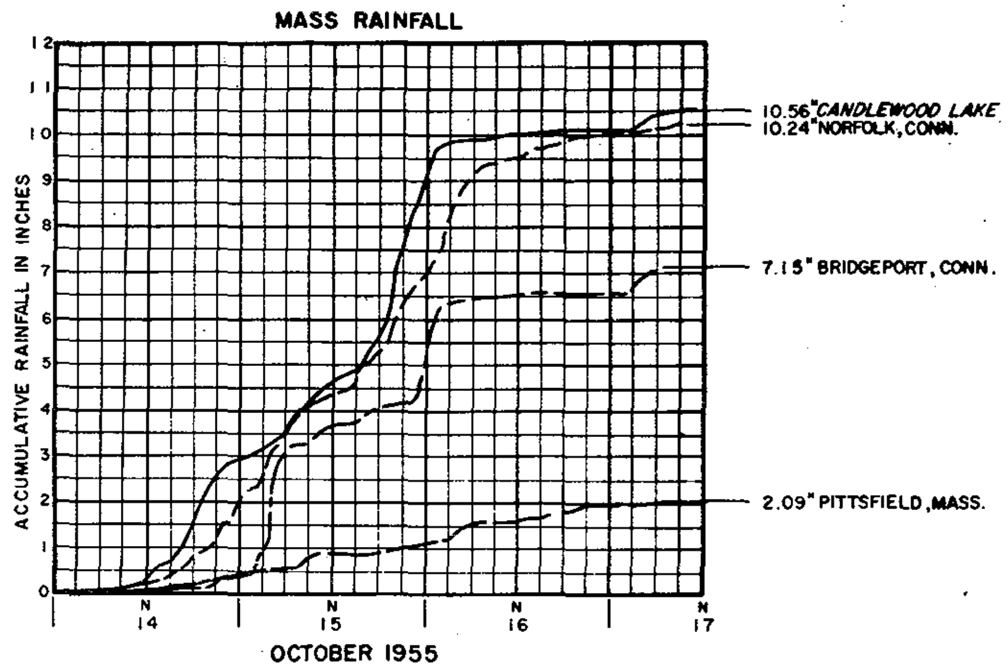


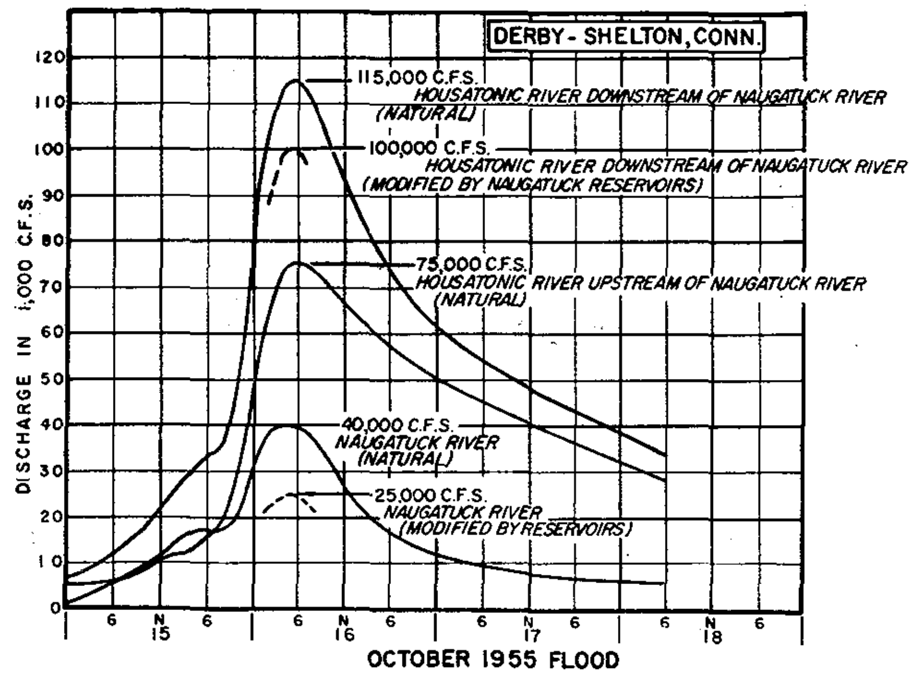
HOUSATONIC RIVER FLOOD CONTROL

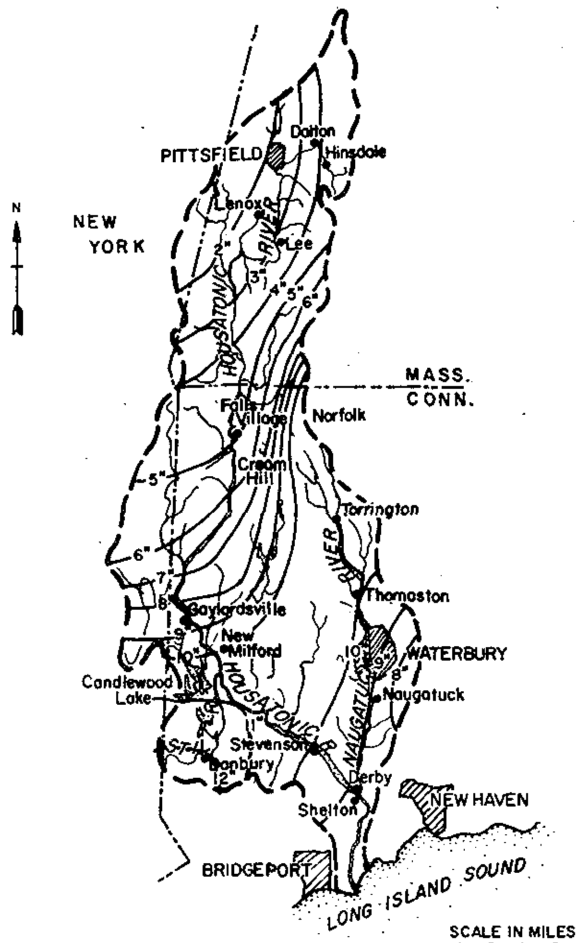
FLOOD OF
AUGUST 17 - 20, 1955
(HURRICANE "DIANE")

U.S.ARMY ENGINEER DIVISION NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

PLATE NO. 1-4







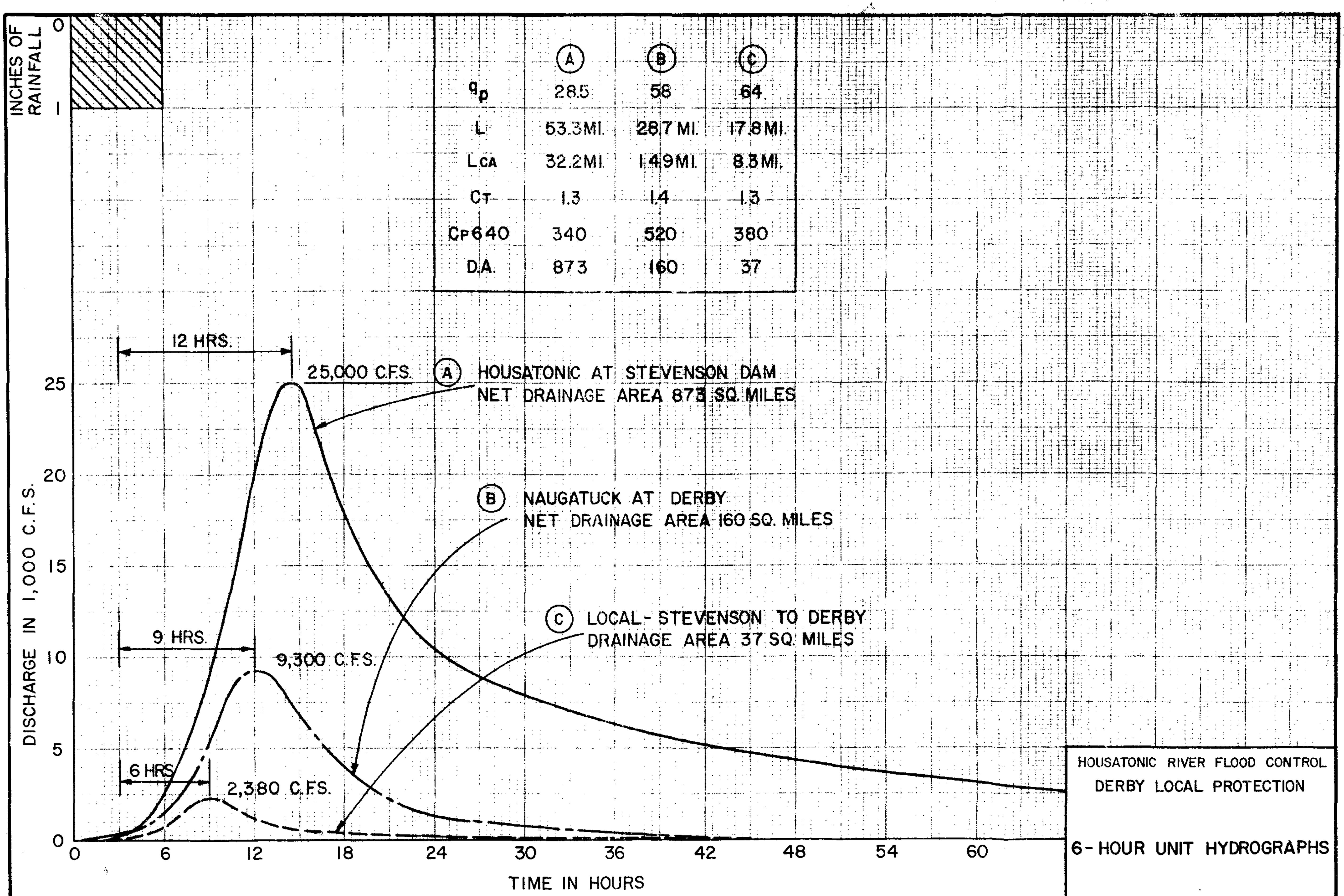
ISOHYETAL MAP
STORM OF
OCTOBER 14-17, 1955

HOUSATONIC RIVER FLOOD CONTROL

FLOOD OF
OCTOBER 14-17, 1955

U.S. ARMY ENGINEER DIVISION NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

PLATE NO. 1-5



HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION

6-HOUR UNIT HYDROGRAPHS

HOUSATONIC RIVER, DERBY CONN.

PLATE NO. 1-6

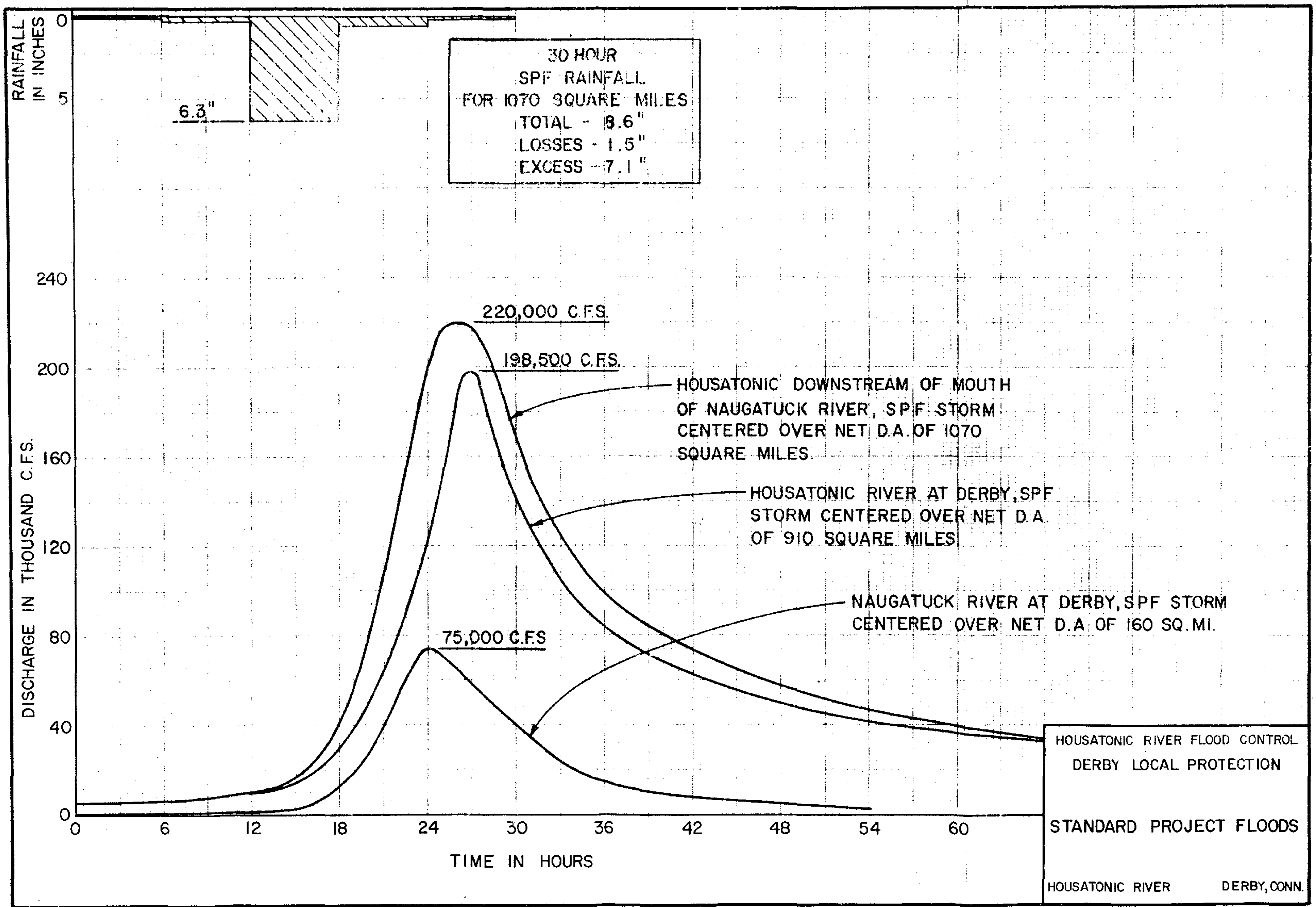
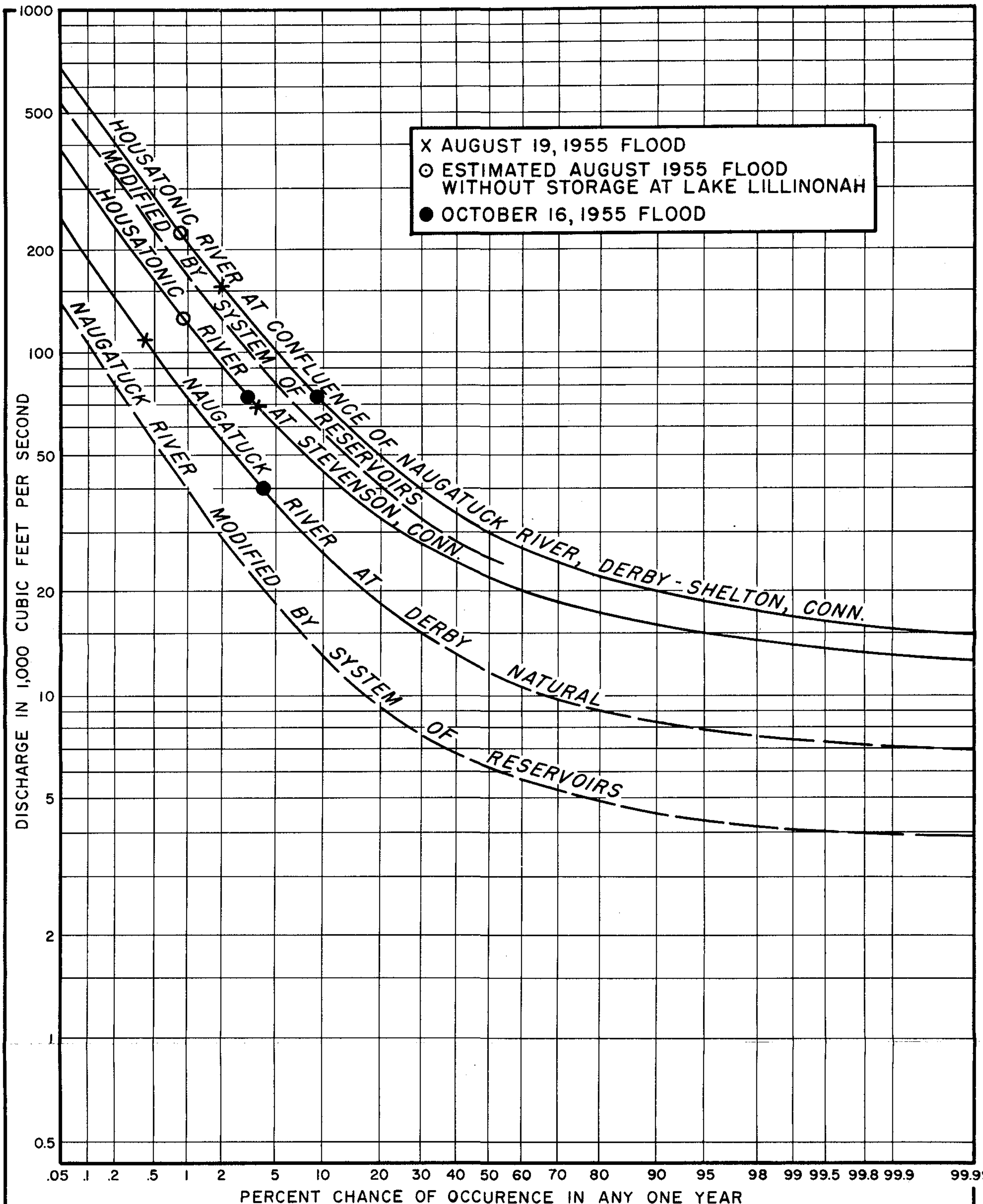

RAINFALL IN INCHES
0
5
6.3"
30 HOUR
SPF RAINFALL
FOR 1070 SQUARE MILES
TOTAL - 8.6"
LOSSES - 1.5"
EXCESS - 7.1"
DISCHARGE IN THOUSAND C.F.S.
240
200
160
120
80
40
0
220,000 C.F.S.
198,500 C.F.S.
75,000 C.F.S
HOUSATONIC DOWNSTREAM OF MOUTH OF NAUGATUCK RIVER, SPF STORM CENTERED OVER NET D.A. OF 1070 SQUARE MILES.
HOUSATONIC RIVER AT DERBY, SPF STORM CENTERED OVER NET D.A. OF 910 SQUARE MILES
NAUGATUCK RIVER AT DERBY, SPF STORM CENTERED OVER NET D.A OF 160 SQ. MI.
0
6
12
18
24
30
36
42
48
54
60
TIME IN HOURS
HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
STANDARD PROJECT FLOODS
HOUSATONIC RIVER
DERBY, CONN.

PLATE NO I - 7



HOUSATONIC RIVER FLOOD CONTROL

DISCHARGE FREQUENCY CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.

PLATE NO. 1-8

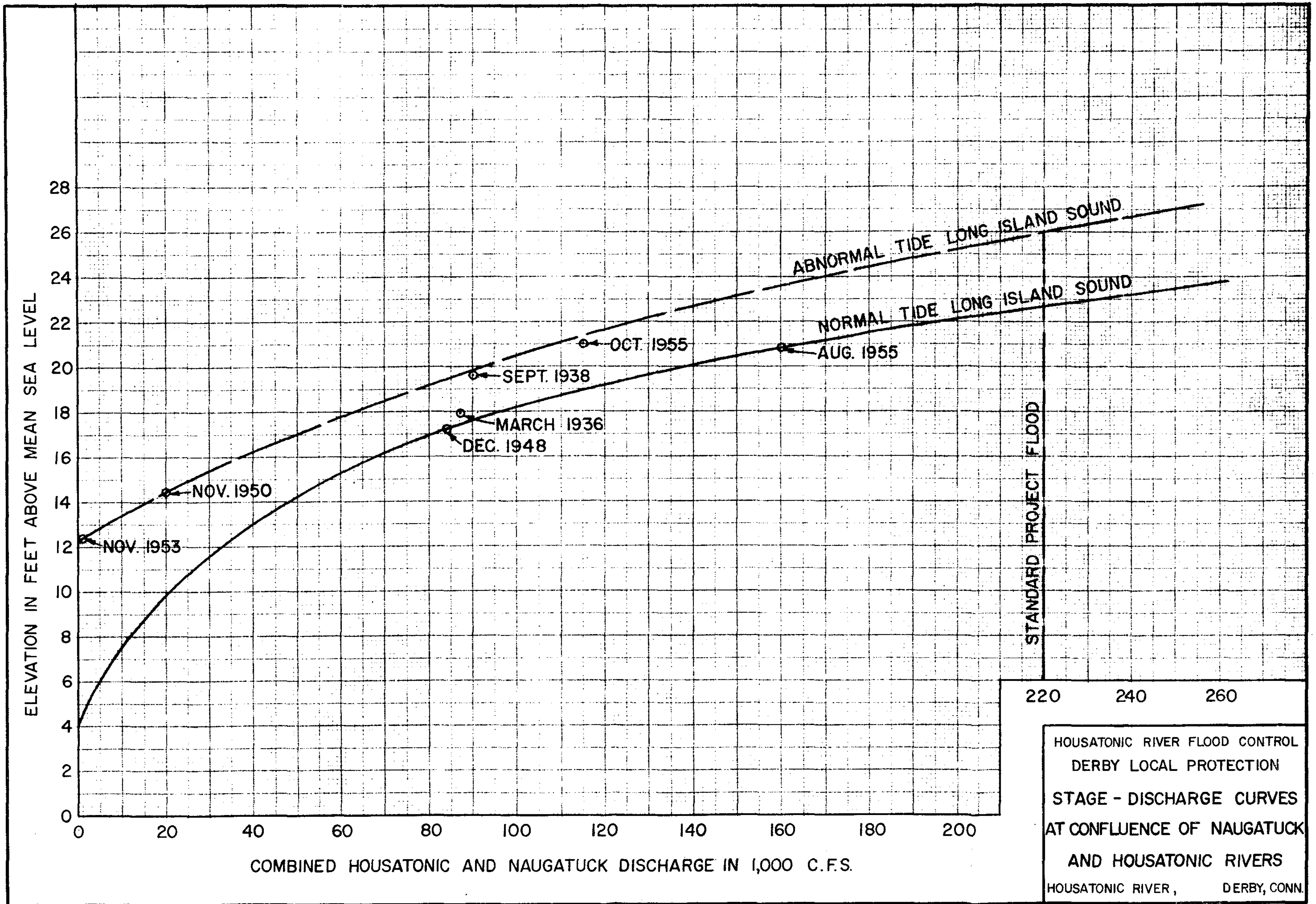
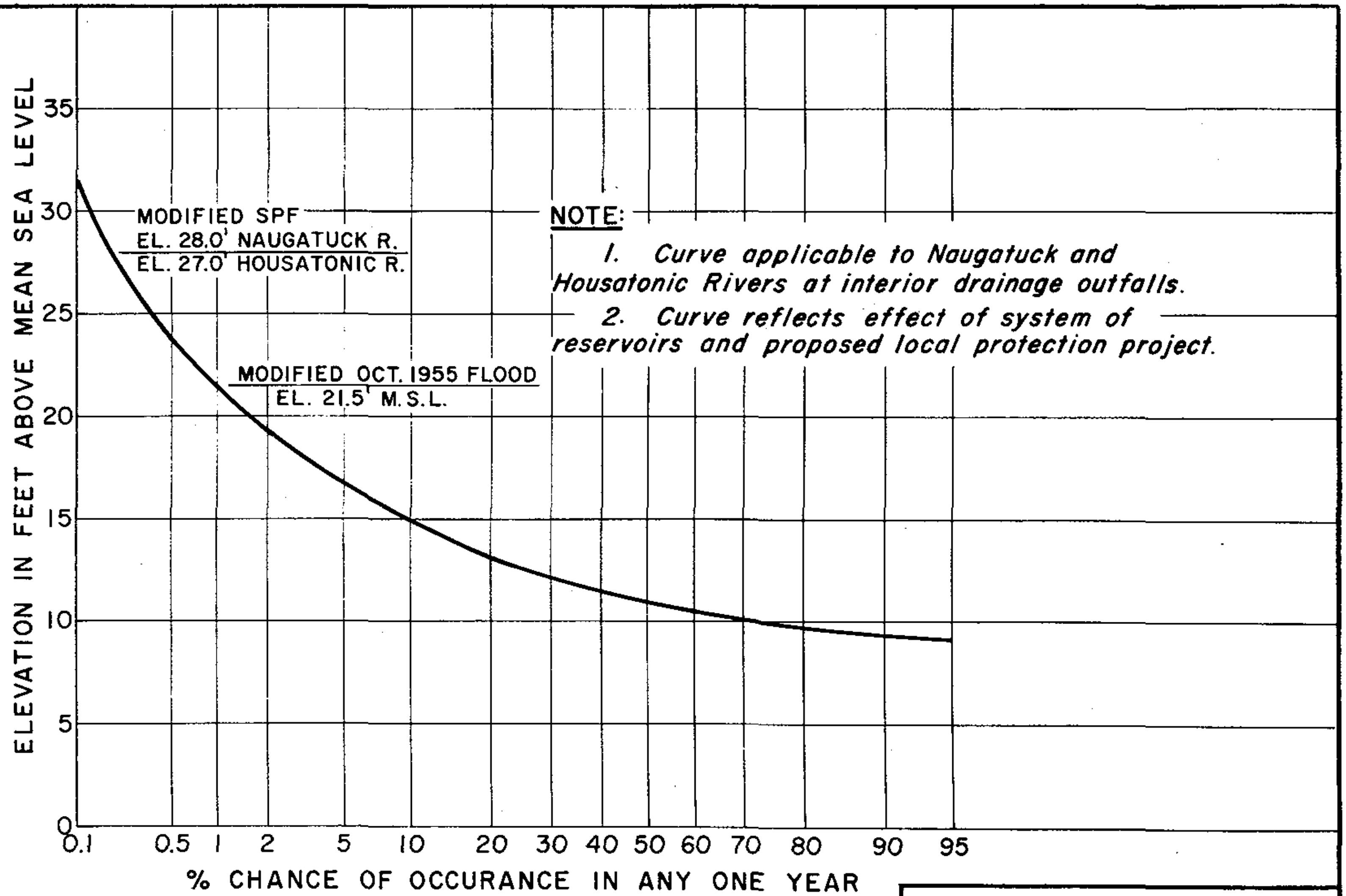

ELEVATION IN FEET ABOVE MEAN SEA LEVEL
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
COMBINED HOUSATONIC AND NAUGATUCK DISCHARGE IN 1,000 C.F.S.
0
20
40
60
80
100
120
140
160
180
200
220
240
260
ABNORMAL TIDE LONG ISLAND SOUND
NORMAL TIDE LONG ISLAND SOUND
STANDARD PROJECT FLOOD
OCT. 1955
AUG. 1955
SEPT. 1938
MARCH 1936
DEC. 1948
NOV. 1950
NOV. 1953
HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
STAGE - DISCHARGE CURVES
AT CONFLUENCE OF NAUGATUCK
AND HOUSATONIC RIVERS
HOUSATONIC RIVER, DERBY, CONN.

PLATE NO. 1-9



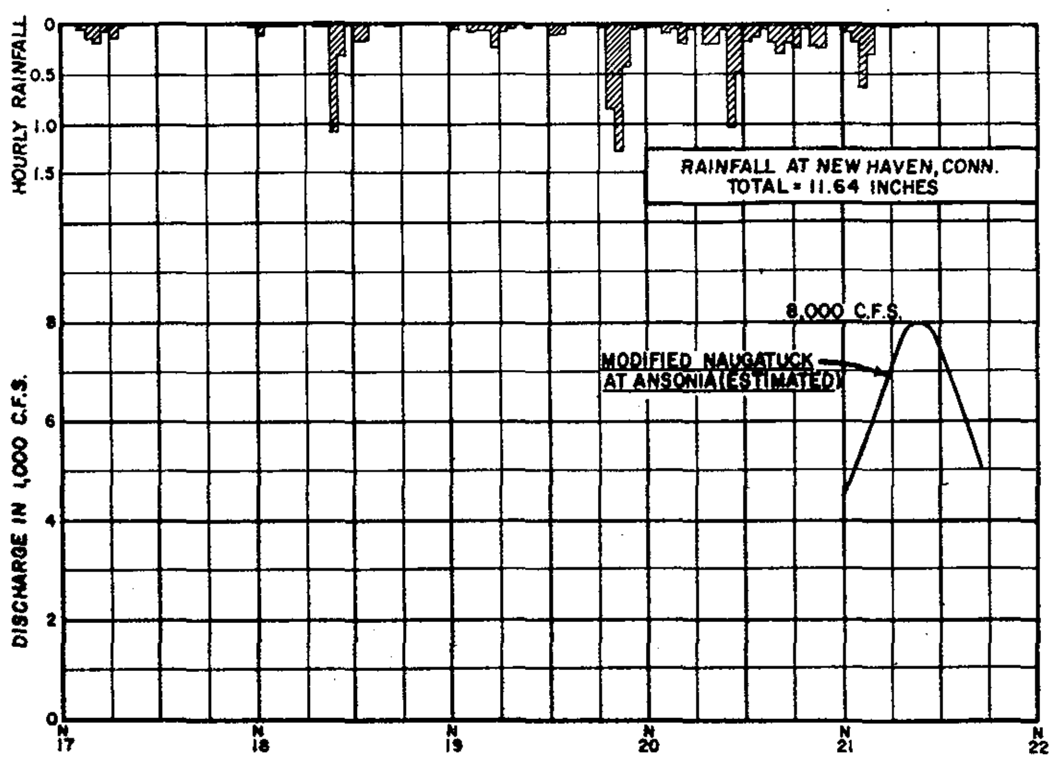
HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

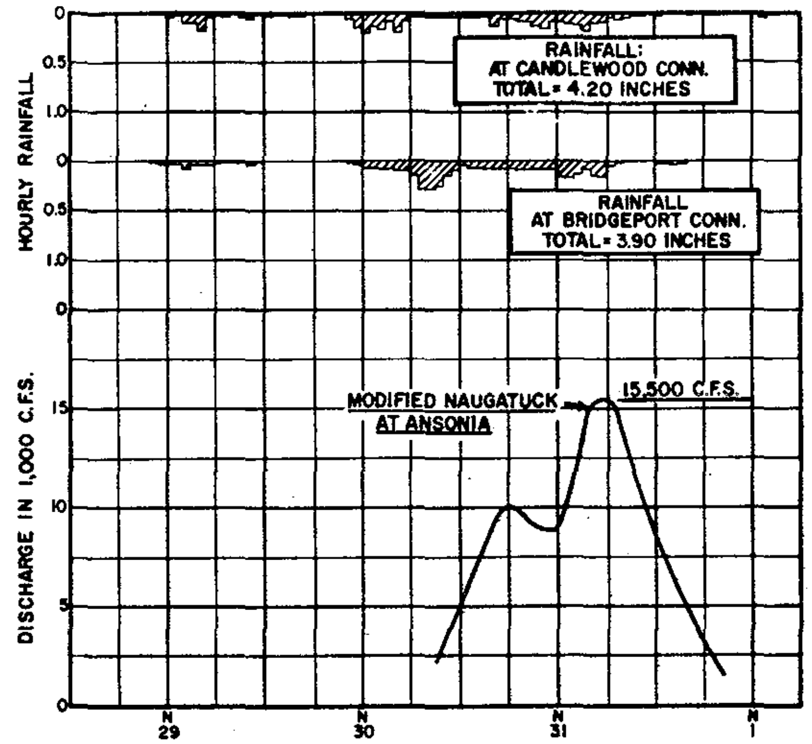
STAGE FREQUENCY CURVE

HOUSATONIC RIVER DERBY, CONN.

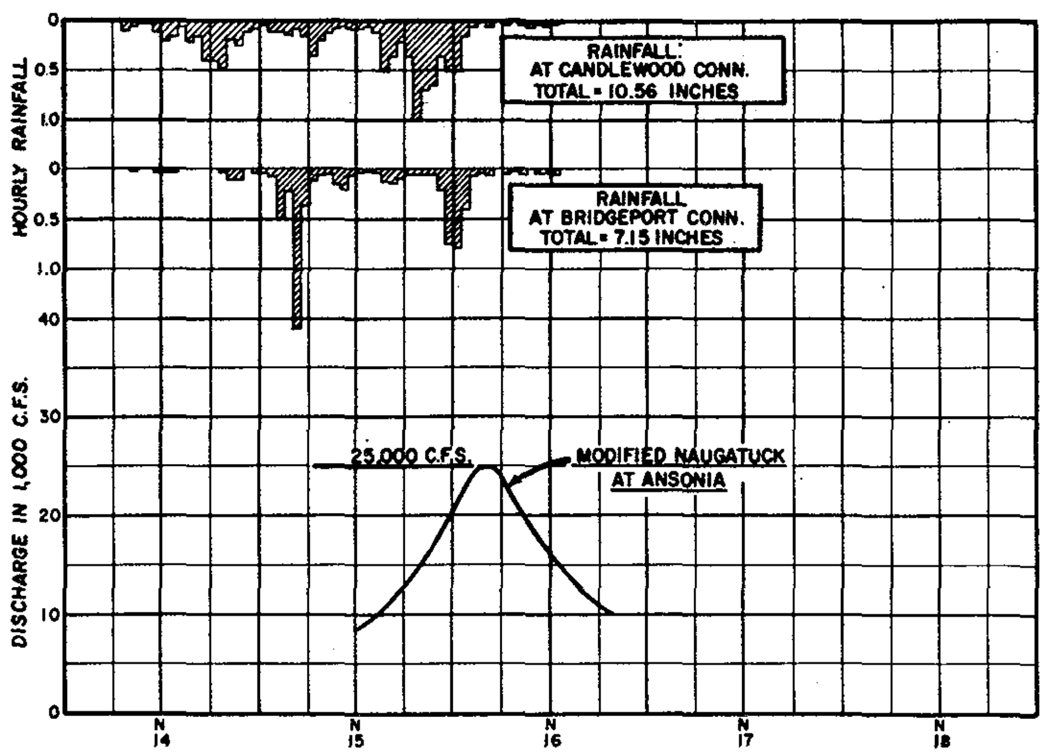
PLATE 1-10



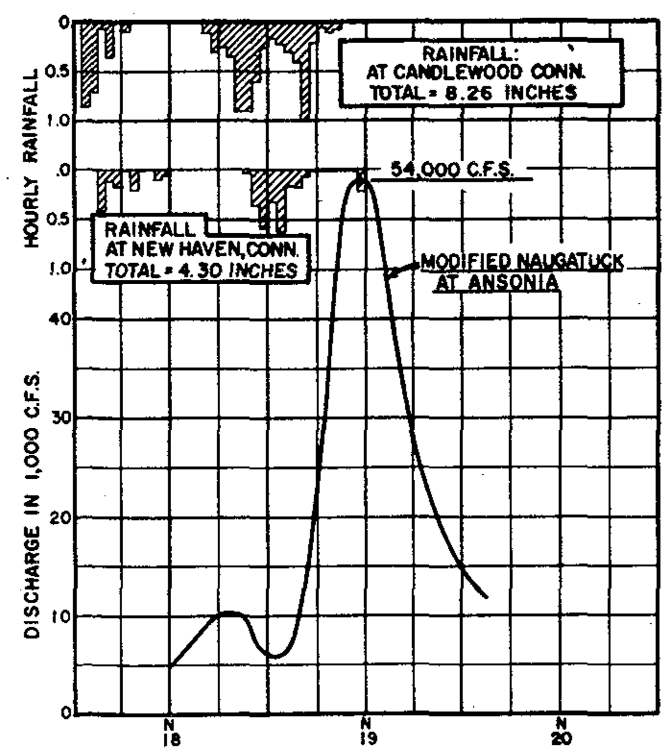
SEPTEMBER 1938



DECEMBER 1948



OCTOBER 1955



AUGUST 1955

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

ENGINEER

SUBMITTED BY:

CHIEF, HYD. & HYD.

APPROVED:

CHIEF, PLANN. & RPTS. BR.

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

COINCIDENCE OF PAST FLOOD STAGES WITH LOCAL RAINFALL

NAUGATUCK RIVER, CONNECTICUT

APPROVED: DATE:

CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN

DRAWING NUMBER

SHEET

PLATE NO. 1-11

CORPS OF ENGINEERS U. S. ARMY

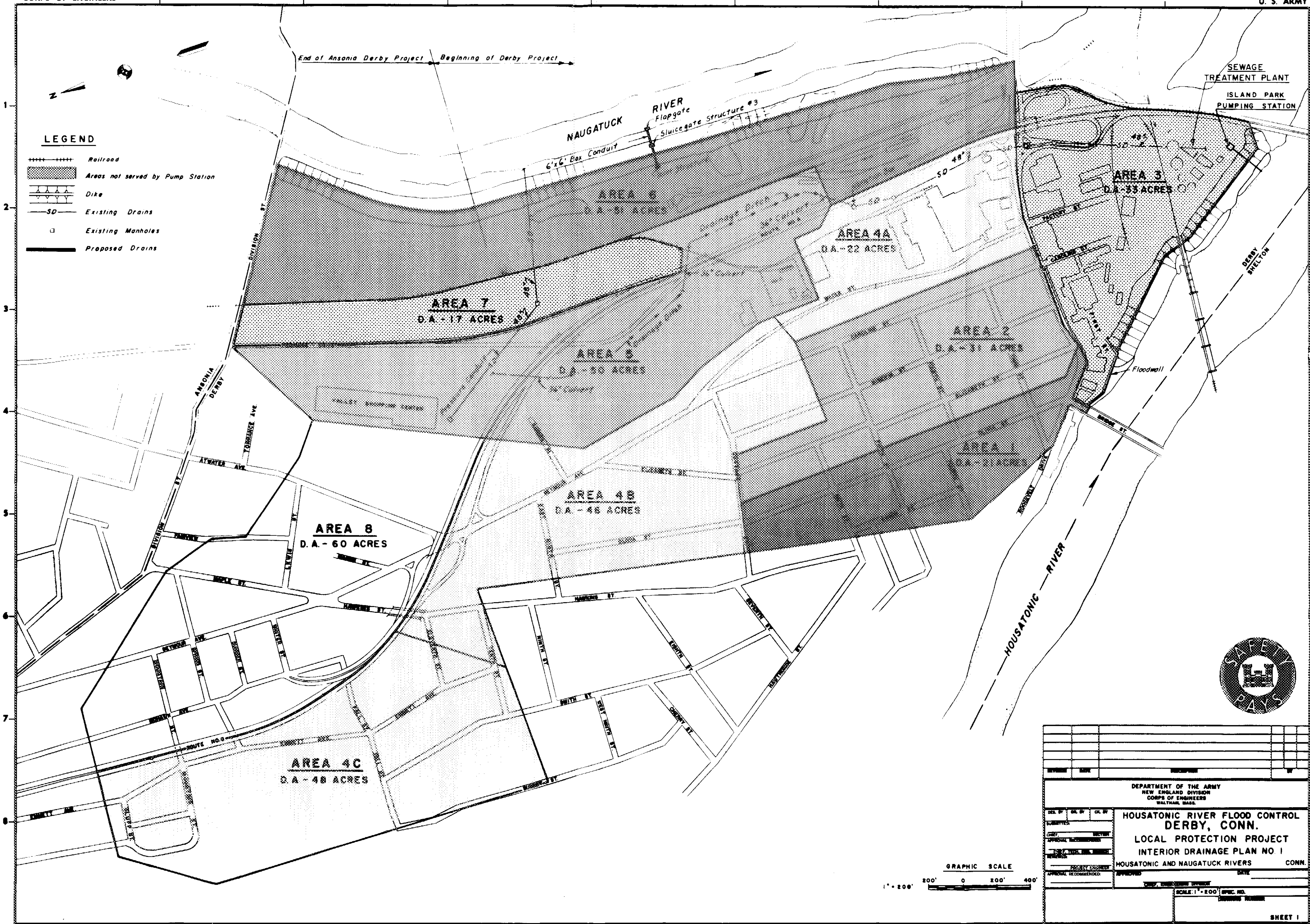
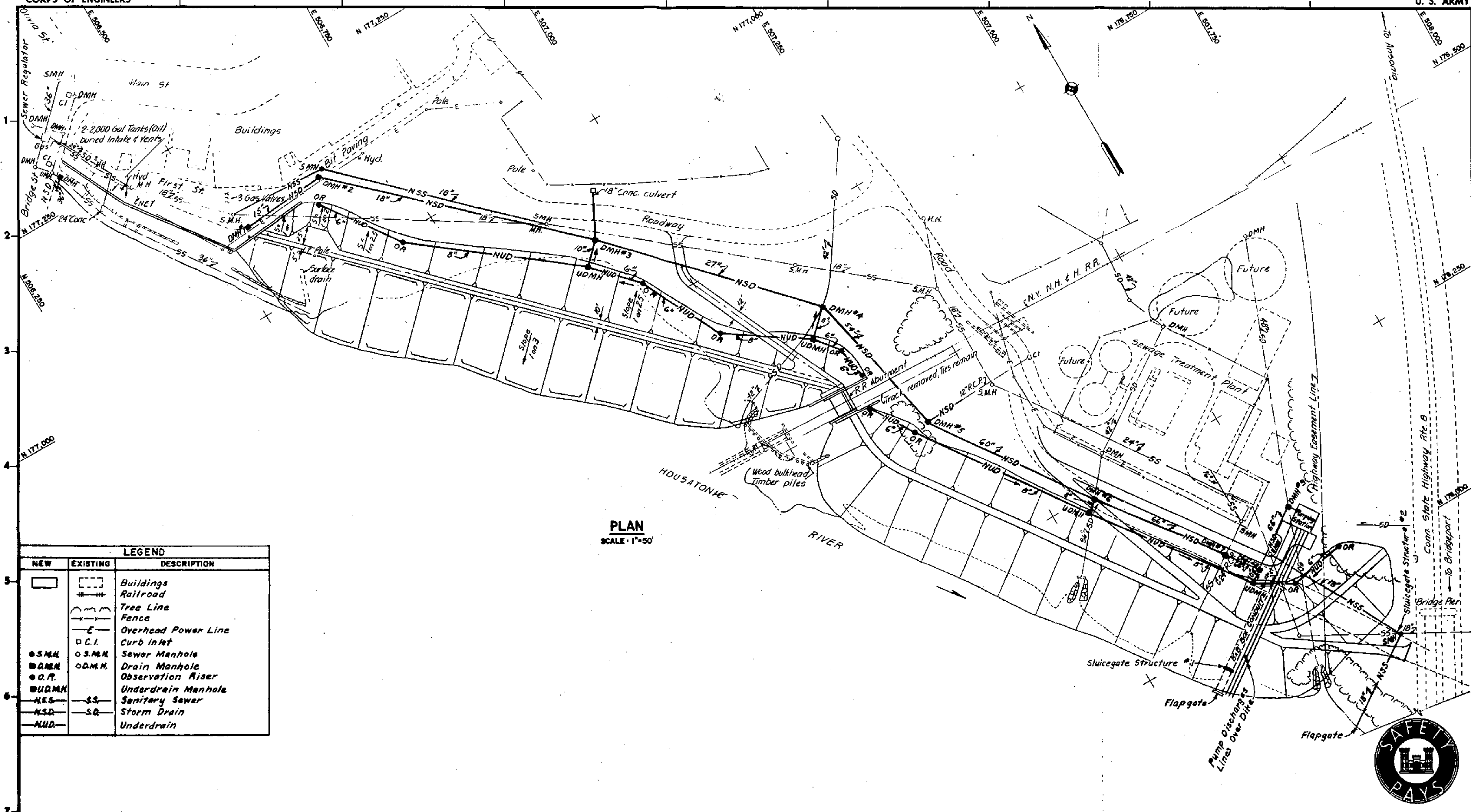


PLATE NO. 1-12

CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE: 1" = 50'

LEGEND		
NEW	EXISTING	DESCRIPTION
		Buildings
		Railroad
		Tree Line
		Fence
	—E—	Overhead Power Line
	C.I.	Curb Inlet
S.M.H.	S.M.H.	Sewer Manhole
D.M.H.	D.M.H.	Drain Manhole
O.R.		Observation Riser
U.D.M.H.		Underdrain Manhole
—N.S.S.—	—S.S.—	Sanitary Sewer
—N.S.D.—	—S.D.—	Storm Drain
—N.U.D.—		Underdrain

GRAPHIC SCALE

1" = 50'-0" 50' 0' 50' 100'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:

CHIEF, SECTION

APPROVAL RECOMMENDED:

CHIEF, TECH. ENG. BRANCH

REVIEWED:

PROJECT ENGINEER

APPROVAL RECOMMENDED:

HOUSATONIC RIVER FLOOD CONTROL
DERBY, CONN.
LOCAL PROTECTION PROJECT
INTERIOR DRAINAGE PLAN NO. 2
HOUSATONIC AND NAUGATUCK RIVERS CONN.

APPROVED DATE

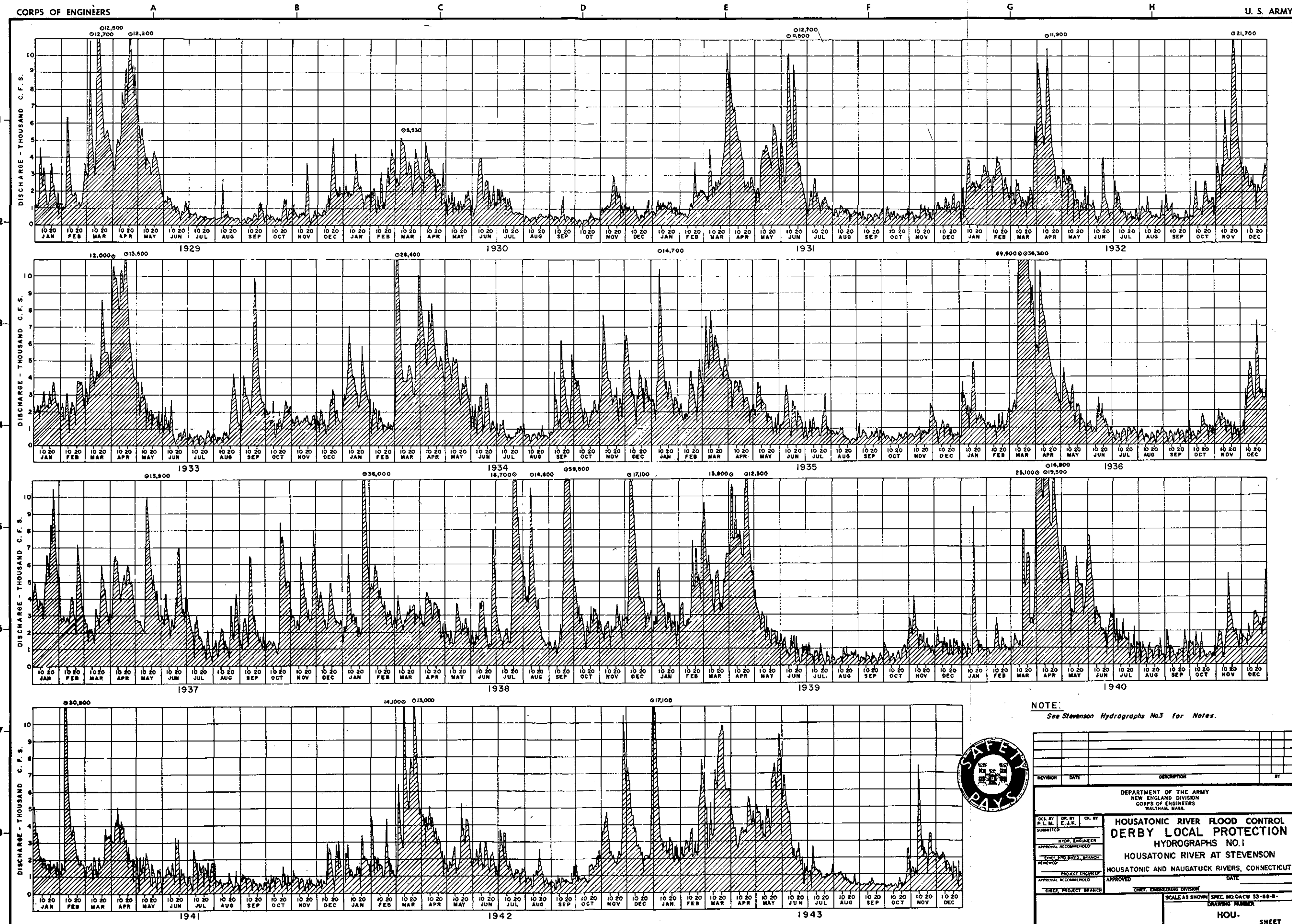
CHIEF, ENGINEERING DIVISION

SCALE 1" = 50' | SPEC. NO.

DRAWING NUMBER

SHEET 2

PLATE NO. I-13



NOTE:

See Stevenson Hydrographs No.3 for Notes.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY P. L. M. | DR. BY E. J. K. | CK. BY

SUBMITTED: HYDR. ENGINEER

APPROVAL RECOMMENDED: CHIEF, HYD. & HYD. BRANCH

REVIEWED: PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

HYDROGRAPHS NO. 1

HOUSATONIC RIVER AT STEVENSON

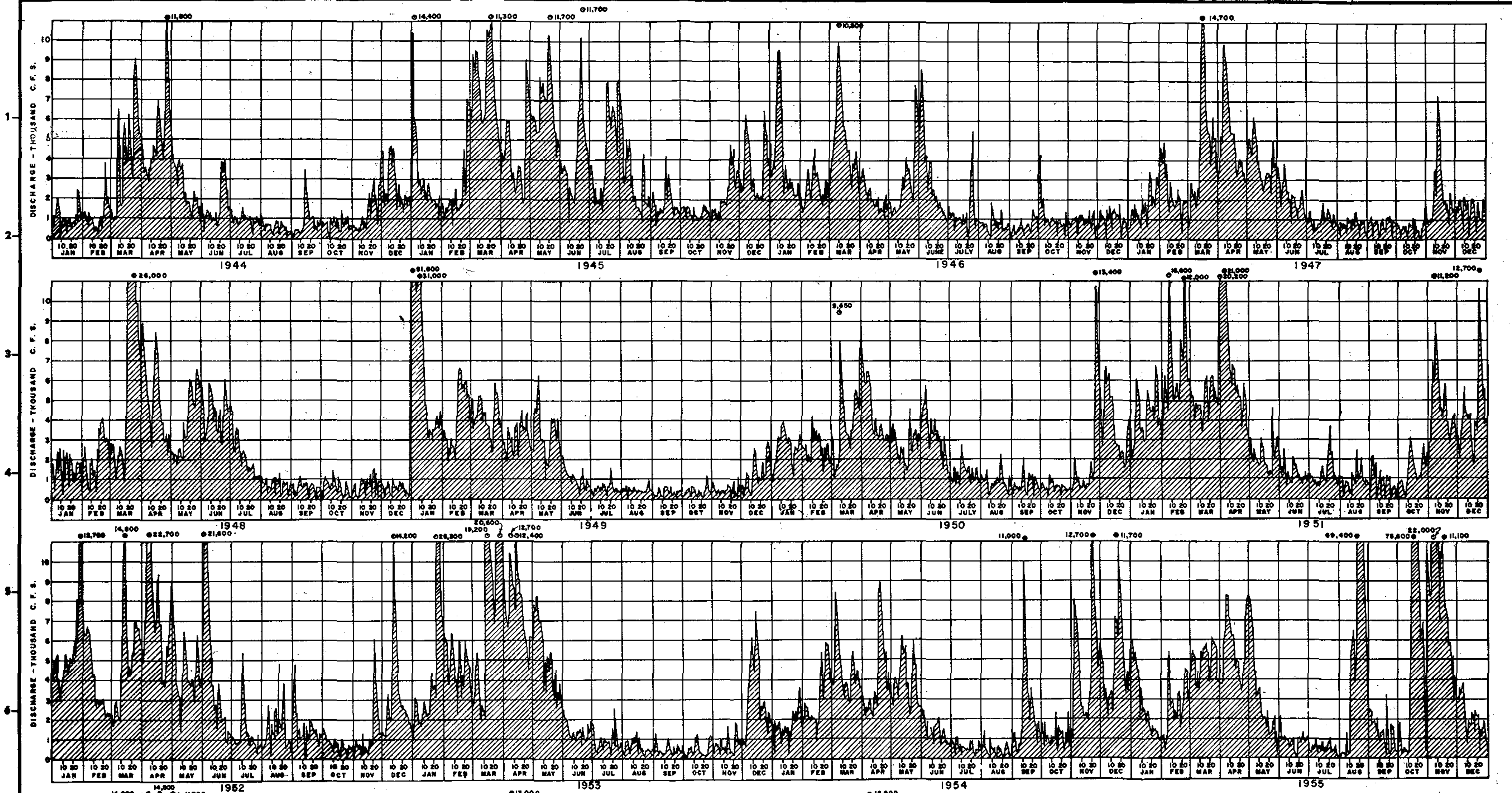
HOUSATONIC AND NAUGATUCK RIVERS, CONNECTICUT

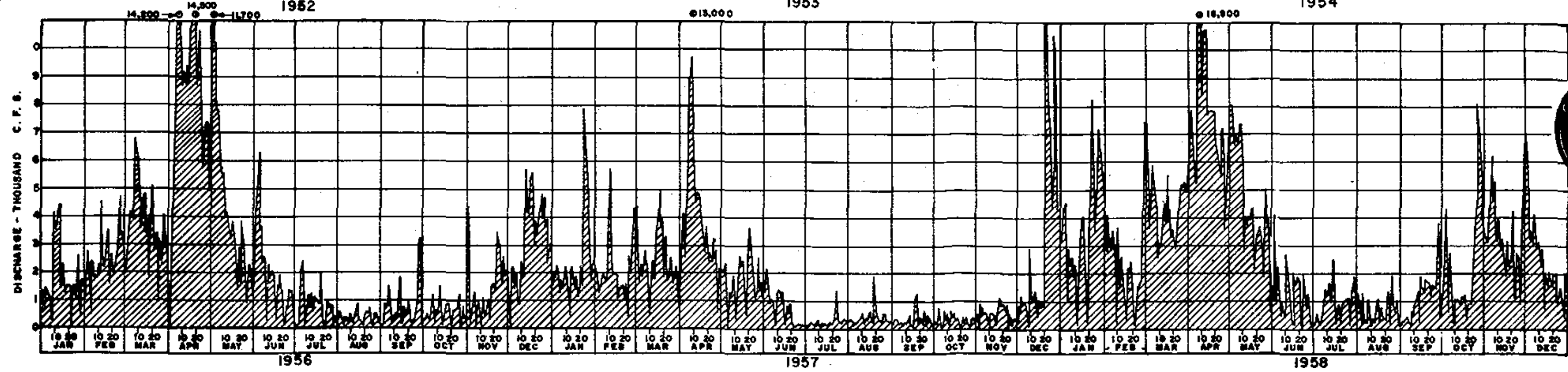
APPROVED: CHIEF, ENGINEERING DIVISION | DATE

SCALE AS SHOWN | SPEC. NO. DACW 33-68-B-

DRAWING NUMBER HOU-

SHEET





NOTE:
See Stevenson Hydrographs No. 3 for Notes.

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY P.L.M. | DR. BY E.J.K. | CK. BY

SUBMITTED: HYDR. ENGINEER
APPROVAL RECOMMENDED: CHIEF, HYD. & HYD. BRANCH
REVIEWED: PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH

HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
HYDROGRAPHS NO. 2
HOUSATONIC RIVER AT STEVENSON
HOUSATONIC AND NAUGATUCK RIVERS, CONNECTICUT

APPROVED: CHIEF, ENGINEERING DIVISION DATE

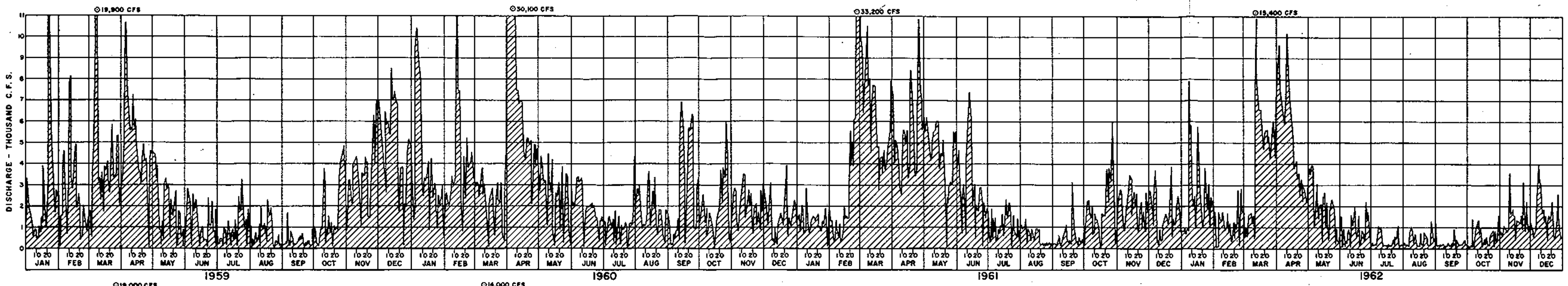
SCALE: AS SHOWN | SPEC. NO. DACW 33-68-B-

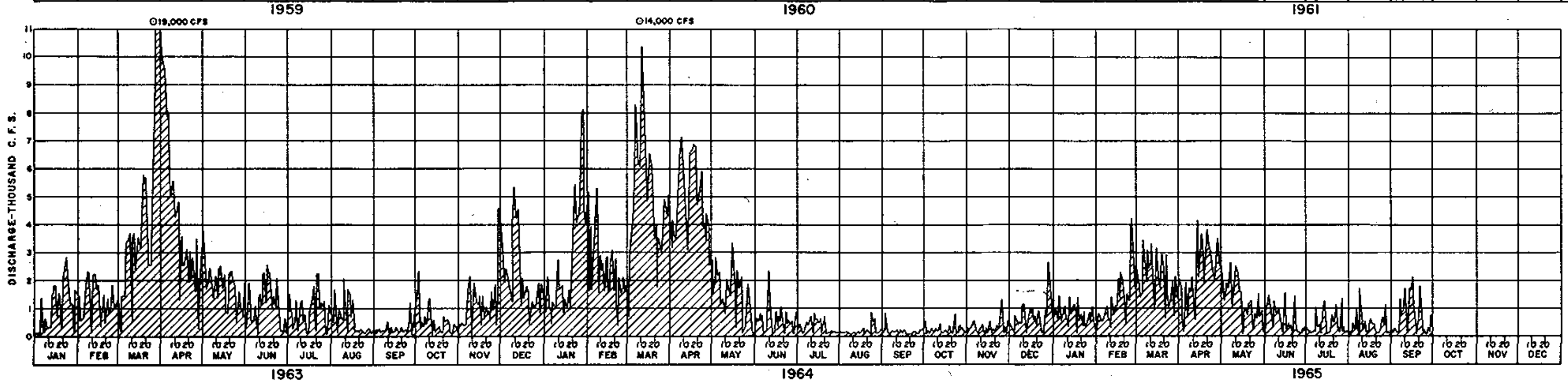
DRAWING NUMBER HOU-

SHEET

PLATE 1-15

CORPS OF ENGINEERS U. S. ARMY

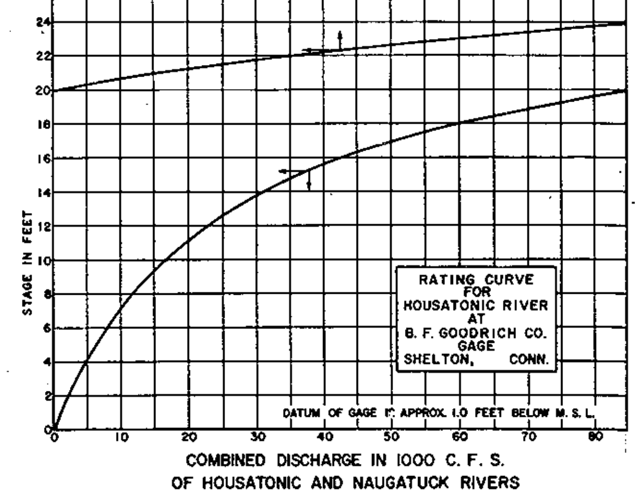




NOTES

1. These hydrographs are the daily average stream flow at the Housatonic River at Stevenson Conn. from the tributary drainage area of 1545 square miles. Some instantaneous peak discharges are shown by ⊙.

2. The data contained hereon are not intended as representations or warranties but are furnished as information only. It is expressly understood that the Government will not be responsible for any deduction, interpretation or conclusion therefrom made by any bidder or contractor.



REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY E.P.S. | DR. BY C.T.M. | CK. BY

SUBMITTED: HYDR. ENGINEER

APPROVAL RECOMMENDED: CHIEF, HYD. & HYD. BRANCH

REVIEWED: PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF, PROJECT BRANCH

HOUSATONIC RIVER FLOOD CONTROL

DERBY LOCAL PROTECTION

HYDROGRAPHS NO.3

HOUSATONIC RIVER AT STEVENSON

HOUSATONIC AND NAUGATUCK RIVERS, CONNECTICUT

APPROVED ____ DATE ____

CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN | SPEC. NO. DACW 33-69-B-

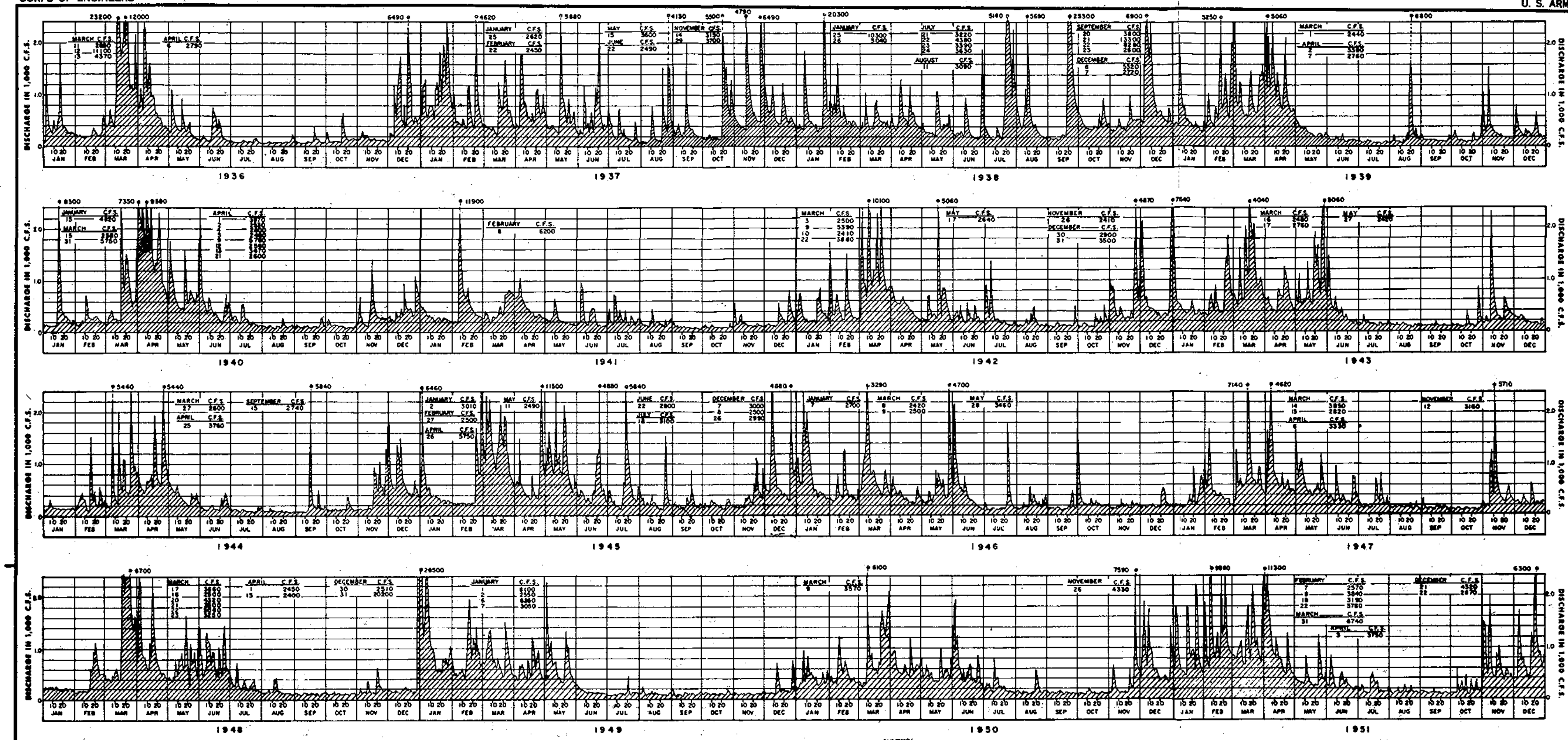
DRAWING NUMBER

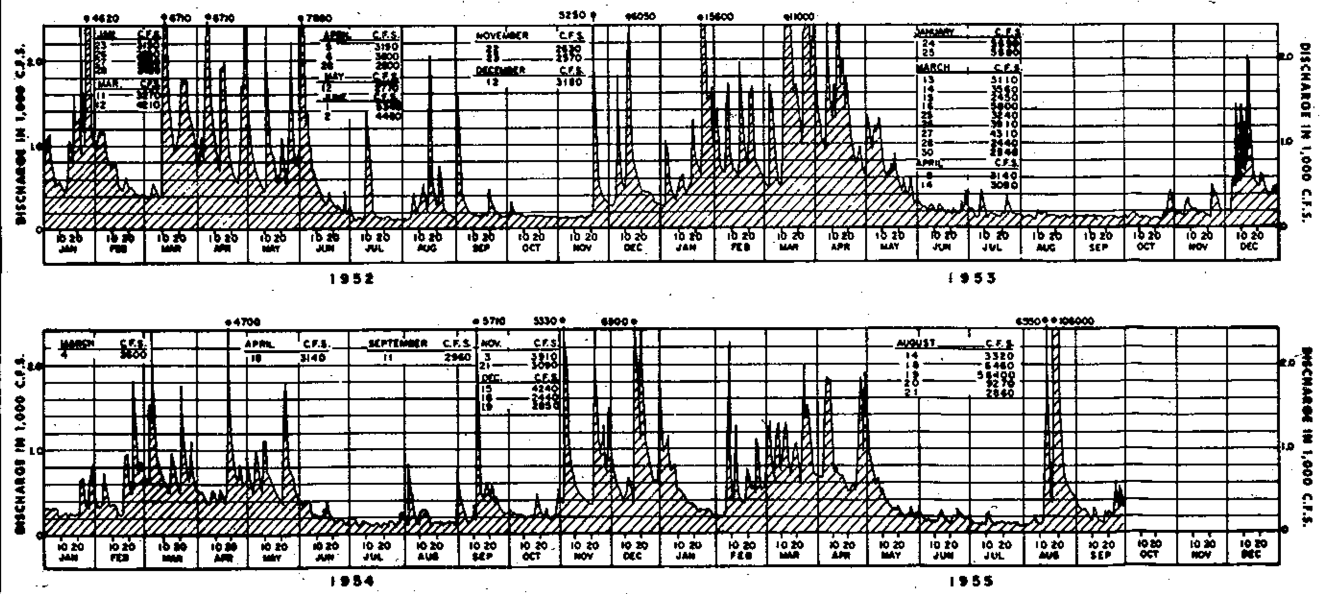
HOU-

SHEET

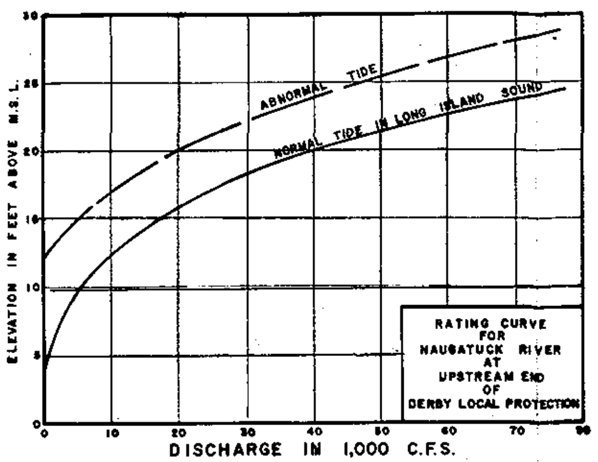
CORPS OF ENGINEERS

U. S. ARMY





NOTES:
1. THESE HYDROGRAPHS ARE THE DAILY AVERAGE STREAMFLOW OF NAUGATUCK RIVER AT NAUGATUCK, CONN. FROM THE TRIBUTARY DRAINAGE AREA OF 246 SQUARE MILES. THE TRIBUTARY DRAINAGE AREA OF THE NAUGATUCK AT ANSONIA IS 306 SQUARE MILES. SOME INSTANTANEOUS PEAK DISCHARGES ARE SHOWN BY ⊙. (FOR LOCATION MAP, SEE SHEET 1&2).
2. REGULATION OF THE SYSTEM OF UPSTREAM RESERVOIRS WILL HAVE NO APPRECIABLE EFFECT ON RIVER FLOWS BELOW APPROXIMATELY 5,000 C.F.S. REGULATION OF RESERVOIRS WILL REDUCE LARGER FLOWS.
3. THE DATA CONTAINED HEREON ARE NOT INTENDED AS REPRESENTATIONS OR WARRANTIES BUT ARE FURNISHED AS INFORMATION ONLY. IT IS EXPRESSLY UNDERSTOOD THAT THE GOVERNMENT WILL NOT BE RESPONSIBLE FOR ANY DEDUCTION, INTERPRETATION OR CONCLUSION THEREFROM MADE BY ANY BIDDER OR CONTRACTOR.



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY P.L.M. DR. BY L.R.L. CK. BY

HOUSATONIC RIVER FLOOD CONTROL
DERBY LOCAL PROTECTION
HYDROGRAPHS
NAUGATUCK RIVER AT NAUGATUCK
HOUSATONIC AND NAUGATUCK RIVERS, CONNECTICUT

SPEC. NO. DACW 33-60-B-

HOU-

SHEET

PLATE 1-17